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Drawing Room Kinks

COMPILED BY

F. H. COLVIN AND F. A. STANLEY

Associate Editors of the American Machinist

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INTRODUCTORY WORD

THE kinks and other information given in this book have been selected from the experience of thoroughly practical men, as originally published in the *American Machinist.* This volume forms one of a series of this nature, aiming always to make available out-of-the-way information when most wanted. In this form the Kink Books, which can be kept in the tool-chest or the pocket, and always referred to, will, we feel, meet a demand and serve a good purpose.

F. H. COLVIN.
F. A. STANLEY.

NEW YORK, November, 1907.

DRAWING ROOM KINKS

STANDARDIZATION OF JIGS AND FIXTURES

THE controlling reasons for making jigs and fixtures are so well known that it is unnecessary to mention them. Some of the important features of designing these special tools are, however, not so well appreciated.

Such a special tool must not only have all of the necessary elements of accuracy but must be quick in manipulation. Too often a designer seems completely to ignore this point, when a very slight modification in holding the work would increase the production enormously.

A tool designer should be intimately acquainted with the machine-tool equipment on which the special tools are to be used. This determines to a considerable extent the sequence of individual operations.

In many factories using a large number of jigs and fixtures special small tools, such as cutters, drills, reamers, taps, counterbores, etc., can be and often are standardized. This point should not be neglected, as it results in a direct and immediate economy.

Still another feature which lends itself to standardization is the design of jigs and fixtures, and their small parts. At first thought it may seem paradoxical to standardize such special tools, where usually only one is ever made from a particular design.

However, such standardization is possible to quite an extent, and to real advantage provided a large amount of tool work is carried on. For instance, a system of drill, reamer and tap bushings, both loose and fixed, can be determined upon. Screws for jigs and fixtures can be systematically designed for kind and size. Straps, or, at least, strap blanks, can be standardized, and carried in stock. Setting spots on milling and planing fixtures can be designed to use a very few standard setting blocks, except for formed work. Again, jig and fixture castings can be classified into types and styles, and these brought to standards to a certain extent.

In this article we will take up the standardization of small drilling jigs and show a few styles of jigs and their parts, which we have used.

Drilling Jigs

In the manufacture of duplicate parts, drilling jigs form one of the greatest factors in economy and accuracy. Whether the operations to be performed are simple or complicated, the drilling jig is an indispensable tool, and in no other operation can jigs or fixtures be used to better advantage than on the drill press.

The much argued question as to whether we should drill before milling or mill before drilling has never yet been answered to the satisfaction of every one, and in all probability it never will be. While some are firmly convinced that we should drill first, others are just as firmly convinced that the best results can be obtained by reversing the operations. Regardless of all discussion, there are certain fixed mechanical ideas that should be respected, and while one part can be drilled first to the best advantage, it is just as necessary to reverse the operations on another part, while still others can be carried through with equally good results by either order of operations. Some parts are of such an irregular shape that a positive location cannot be obtained except by means of drilled and reamed holes, which necessitates drilling first. On the other hand, with properly constructed jigs, there is less chance for error when locating from a planed, milled or ground surface. It has been proved that in many instances the parts can be located in the jigs and drilled from the planing or milling with a greater degree of accuracy than they can be planed or milled from the drilled holes. Again, the error in setting the tool or cutter is apt to be greater than in locating the part in the jig.

There are many good points in each argument, but the shape of the part and the nature of the operations must determine the order of the operations.

There are several styles of jigs to be considered in taking up the question of standardizing, each one of which is especially adapted to some particular class of work.

After these styles are selected, castings for a few standard sizes of each style can be made and carried in stock. From these castings jigs can be easily and cheaply made which will meet the requirements of a great many small parts. A few standard sizes of the different styles of straps which are most commonly used can be made and carried in stock. Blanks for bushings of various styles and sizes can be made to be finished as required. Screws which are commonly used for jig purposes can easily be standardized. This system will allow the different parts to be cheaply made in quantities and on a manufacturing basis.

THE OPEN JIG

One of the most common types of jigs in general use and one that is adapted to a great many parts is the *open jig,* Fig. 1. Some convenient sizes to carry in stock are as follows:

Width of Body.	Length of Body.	Hight of Base.
2 in.	3 in.	2 in.
3 in.	4½ in.	3 in.
4 in.	6 in.	4 in.
6 in.	9 in.	6 in.

Seats can be planed in the castings to suit each particular part; or, if a large number of parts are to be produced in a jig, it may receive a hardened-steel seat. Stops, screws and straps can be placed where needed, and steel bushings or linings can be inserted. These castings will be found very convenient in making jigs for small parts which are to be drilled from one surface only.

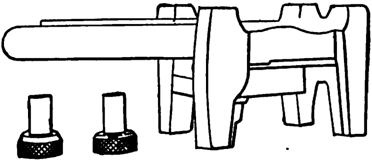


FIG. 1. — Standard Type of Open Jig.

A convenient strap to use with these jigs is shown in Fig. 14. These straps should be made of bessemer steel and case-hardened after finishing. The slot *G* for the binding screw should not be cut until the strap is selected for use. It can then be located in the proper position and made of such dimensions as to allow the strap to be slipped back out of the way when work is being placed in and taken from the jig.

THE BOX JIG

Another type of jig in common use is the ***box jig***. This jig is generally used when holes are to be drilled in two or more sides of the work. Work may be held in these jigs by means of straps and set-screws, or by hinge covers and set-screws, as the nature of the part requires. Such a jig, with a hinge cover, is shown in Fig. 2. Castings of the same general sizes as for the *open jig* will be found convenient if carried in stock.

In Fig. 2 a hinge screw with a wing nut is used to clamp the hinge cover. When this is not convenient, a screw such as shown in Fig. 10 may be used with good results. This screw, when used, should be adjusted so that only a quarter turn will be needed to clamp or release the cover, which should be slotted to admit the head of the screw.

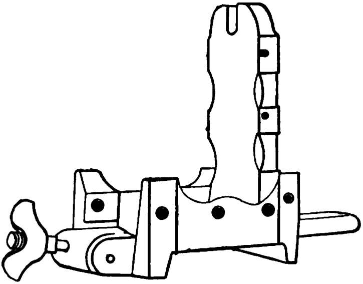


FIG. 2. — Standard Type of Box Jig.

ANOTHER STANDARD JIG

In Fig. 3 is shown another type of jig which is very useful in drilling set-screw holes in collars,

Size of Base.	Hight.
3 in. x 3 in.	3 in.
4 in. x 4 in.	4 in.
6 in. x 6 in.	6 in.

hubs of pulleys, gears, cams, etc. A jig of this description can often be used for several parts, when interchangeable studs and slip bushings can be made to suit each part. Convenient sizes for castings are shown in above table.

The overhanging arm for the bushings should be cast long and cut off to the required length. The work should be clamped by means of a split washer and set-screw in the end of the stud. Stops can be easily arranged to locate the work.

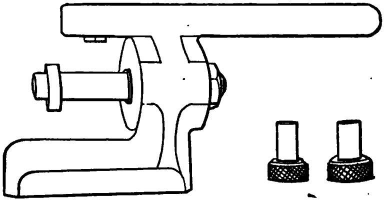
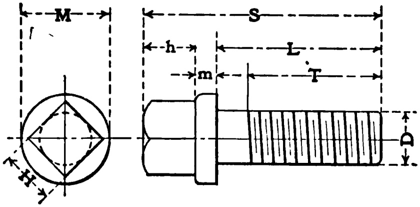


FIG. 3. — Another Standard Type.

It is not to be understood that a standard stock of castings can be carried that will meet a majority of requirements, but if some are carried, it will be surprising to find the number of parts for which they can be adapted.

BINDING SCREWS

Binding screws should be made in various sizes and with threads to conform to the standard taps with which the shop is provided. When drills of a very large size are used, a screw with a square or hexagon head is best, as the work requires firm clamping. If the drills used are small, a winged screw will be sufficient and more convenient, as it will require less time to manipulate. Some good screws for clamping straps are

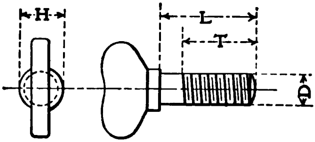


D	Thrd.	L	T	h	m	H	M	S
$\frac{1}{4}$	Shop Standard	1	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{7}{16}$	$1\frac{11}{32}$
$\frac{5}{16}$		1	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{1}{2}$	$1\frac{7}{16}$
$\frac{3}{8}$		$1\frac{1}{2}$	1	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	2
$\frac{7}{16}$		2	$1\frac{1}{2}$	$\frac{7}{16}$	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{11}{16}$	$2\frac{5}{8}$
$\frac{1}{2}$		2	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{16}$	$\frac{1}{2}$	$\frac{13}{16}$	$2\frac{11}{16}$

FIG. 4. — Collar Head Jig Screws.

shown in Figs. 4 and 5. General standard dimensions are given. Of course screws can be made of any length desired.

When the work is to be held against the seat or a stop by means of a set-screw, such screws as shown in Figs. 6 and 7 will be found very useful. General dimensions are also given. If, however, the work is very light, a wing screw can be used.

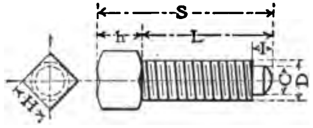


D	Thrd.	H	L	T
$\frac{1}{4}$	Shop Standard	$\frac{3}{8}$	1	$\frac{3}{4}$
$\frac{5}{16}$		$\frac{7}{16}$	1	$\frac{3}{4}$
$\frac{3}{8}$		$\frac{1}{2}$	$1\frac{1}{2}$	1

FIG. 5. — Winged Jig Screws.

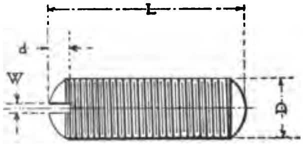
SUPPORTING SCREWS

Figs. 8 and 9 show screws that are very useful in supporting work against the thrust of drills when the work is of such a nature that it cannot be supported otherwise.



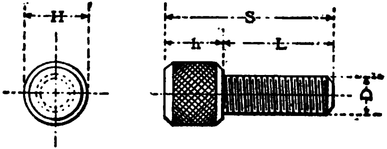
D	Thrd.	L	h	I	C	H	S
1/4	Shop Standard	1	1/4	1/8	5/32	1/4	1 1/4
5/16		1	5/16	1/8	13/64	5/16	1 5/16
3/8		1 1/2	3/8	1/8	17/64	3/8	1 7/8
7/16		1 1/2	7/16	3/16	5/16	7/16	1 15/16
1/2		1 1/2	1/2	3/16	11/32	1/2	2

FIG. 6. — Square-Head Jig Screws.



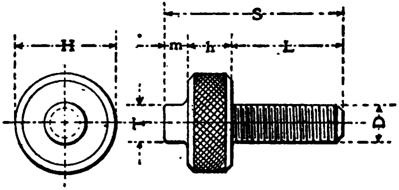
D	Thrd.	L	W	d
3/16	Shop Standard	1/2	.062	1/16
1/4		3/4	.040	3/32
5/16		1	.057	3/32
3/8		1	1/16	1/8
7/16		1 1/2	5/64	1/8
1/2		1 1/2	5/64	1/8

FIG. 7. — Headless Jig Screws.



D	Thrd.	L	h	S	H
$\frac{1}{4}$	Shop Standard	$\frac{3}{4}$	$\frac{3}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$
$\frac{5}{16}$		1	$\frac{1}{2}$	$1\frac{1}{2}$	$\frac{9}{16}$
$\frac{3}{8}$		1	$\frac{9}{16}$	$1\frac{9}{16}$	$\frac{5}{8}$

FIG. 8. — Nurled Head Jig Screws.



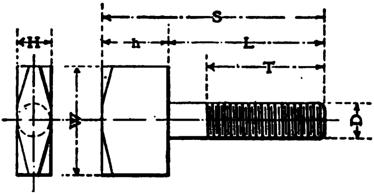
D	Thrd.	L	h	m	S	H	T
$\frac{1}{4}$	Shop Standard	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{4}$
$\frac{5}{16}$		1	$\frac{3}{8}$	$\frac{7}{32}$	$1\frac{19}{32}$	$\frac{7}{8}$	$\frac{5}{16}$
$\frac{3}{8}$		1	$\frac{7}{16}$	$\frac{1}{4}$	$1\frac{11}{16}$	1	$\frac{3}{8}$

FIG. 9. — Nurled Head Jig Screws.

LOCKING SCREW

A convenient hinge-cover locking screw is shown in Fig. 10, together with standard dimensions.

The different sizes of the styles of screws shown are not only used with drilling jigs, but are equally useful with other jigs and fixtures. These screws should be made of screw stock and case-hardened.



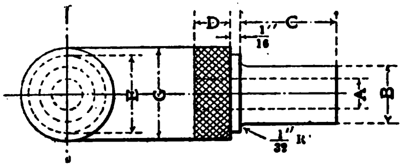
D	Thrd.	H	h	L	S	T	W
$\frac{5}{16}$	Shop Standard	$\frac{5}{16}$	$\frac{5}{8}$	$1\frac{1}{2}$	$2\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{16}$
$\frac{3}{8}$		$\frac{3}{8}$	$\frac{11}{16}$	$1\frac{5}{8}$	$2\frac{5}{16}$	$1\frac{1}{8}$	$1\frac{3}{16}$
$\frac{7}{16}$		$\frac{7}{16}$	$\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{5}{16}$
$\frac{1}{2}$		$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{5}{8}$	$1\frac{1}{4}$	$1\frac{5}{16}$

FIG. 10. — Locking Jig Screws.

BUSHINGS

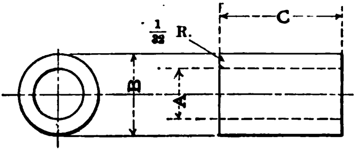
When drilling and reaming operations are to be performed in the same jig, two slip bushings, one for the drill and the other for the reamer, should be used; if the jig is to be used for a large number of parts, the hole for the bushings should in turn be bushed with a steel lining to prevent wearing. The soft cast iron will wear rapidly if this is not done, and the jig will soon have to be rebored and rebushed.

Three different styles of bushings and dimensions are shown in Figs. 11, 12 and 13. These can be blanked out on screw machines and finished to required sizes as needed, and should be made of tool steel. Allowances should be made in the blanks for grinding and lapping after hardening. Fig. 11 shows a slip bushing; Fig. 12 shows a stationary bushing, and Fig. 13 shows a stationary bushing where tools with stop collars are to be used. Such bushings as shown in Figs. 12 and 13 are also used for linings for slip bushings.



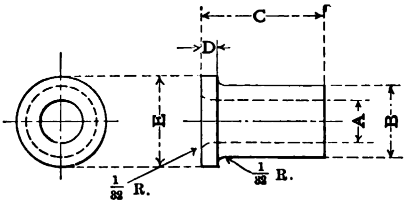
A	B	C	D	E	G
No. 52	1/4	9/16	1/4	7/16	9/16
No. 30	5/16	5/8	1/4	1/2	5/8
No. 12	3/8	5/8	5/16	9/16	11/16
1/4	1/2	11/16	5/16	11/16	13/16
5/16	9/16	3/4	5/16	3/4	7/8
3/8	5/8	3/4	3/8	13/16	15/16
7/16	11/16	13/16	3/8	7/8	1
1/2	3/4	7/8	7/16	15/16	1 1/16
9/16	13/16	7/8	7/16	1	1 1/8
5/8	7/8	15/16	1/2	1 1/16	1 3/16
11/16	15/16	1	1/2	1 1/8	1 1/4
3/4	1 1/16	1	9/16	1 1/4	1 7/16
13/16	1 1/8	1 1/16	9/16	1 5/16	1 1/2
7/8	1 1/4	1 1/8	5/8	1 7/16	1 5/8
15/16	1 5/16	1 3/16	5/8	1 1/2	1 11/16
1	1 3/8	1 1/4	11/16	1 9/16	1 3/4

FIG. 11. — Loose Bushings for Jigs.



A	B	C
52	$\frac{1}{4}$	$\frac{9}{16}$
30	$\frac{5}{16}$	$\frac{9}{16}$
12	$\frac{3}{8}$	$\frac{9}{16}$
$\frac{1}{4}$	$\frac{7}{16}$	$\frac{9}{16}$
$\frac{5}{16}$	$\frac{1}{2}$	$\frac{5}{8}$
$\frac{3}{8}$	$\frac{9}{16}$	$\frac{5}{8}$
$\frac{7}{16}$	$\frac{5}{8}$	$\frac{5}{8}$
$\frac{1}{2}$	$\frac{11}{16}$	$\frac{11}{16}$
$\frac{9}{16}$	$\frac{3}{4}$	$\frac{3}{4}$
$\frac{5}{8}$	$\frac{7}{8}$	$\frac{3}{4}$
$\frac{11}{16}$	$\frac{15}{16}$	$\frac{13}{16}$
$\frac{3}{4}$	1	$\frac{7}{8}$
$\frac{13}{16}$	$1\frac{1}{16}$	$\frac{7}{8}$
$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{15}{16}$
$\frac{15}{16}$	$1\frac{3}{16}$	1
1	$1\frac{1}{4}$	1

Fig. 12. — Fixed Bushings for Jigs.

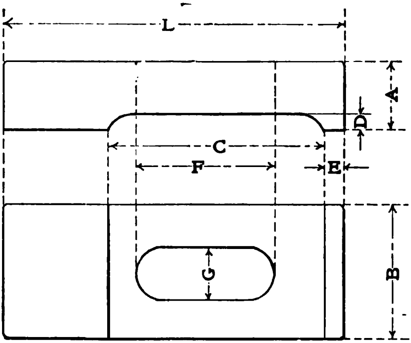


A	B	C	D	E
$\frac{1}{4}$	$\frac{7}{16}$	$\frac{11}{16}$	$\frac{3}{32}$	$\frac{9}{16}$
$\frac{5}{16}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{32}$	$\frac{5}{8}$
$\frac{3}{8}$	$\frac{9}{16}$	$\frac{13}{16}$	$\frac{3}{32}$	$\frac{11}{16}$
$\frac{7}{16}$	$\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{32}$	$\frac{3}{4}$
$\frac{1}{2}$	$\frac{11}{16}$	$\frac{7}{8}$	$\frac{3}{32}$	$\frac{13}{16}$
$\frac{9}{16}$	$\frac{3}{4}$	$\frac{15}{16}$	$\frac{1}{8}$	$\frac{7}{8}$
$\frac{5}{8}$	$\frac{7}{8}$	1	$\frac{1}{8}$	$1\frac{1}{16}$
$\frac{11}{16}$	$\frac{15}{16}$	$1\frac{1}{16}$	$\frac{1}{8}$	$1\frac{1}{8}$
$\frac{3}{4}$	1	$1\frac{1}{8}$	$\frac{1}{8}$	$1\frac{3}{16}$
$\frac{13}{16}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$\frac{1}{8}$	$1\frac{1}{4}$
$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$\frac{5}{32}$	$1\frac{5}{16}$
$\frac{15}{16}$	$1\frac{3}{16}$	$1\frac{5}{16}$	$\frac{5}{32}$	$1\frac{3}{8}$
1	$1\frac{1}{4}$	$1\frac{5}{16}$	$\frac{5}{32}$	$1\frac{7}{16}$

FIG. 13. — Fixed Bushings for Jigs.

STRAPS

A standard strap is shown by Fig. 14. A table of dimensions is also given, omitting *G*



A	B	C	D	E	L
$\frac{1}{2}$	1	$1\frac{5}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$2\frac{1}{2}$
$\frac{1}{2}$	1	$1\frac{5}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	3
$\frac{5}{8}$	$1\frac{1}{4}$	2	$\frac{1}{8}$	$\frac{3}{16}$	$3\frac{1}{2}$
$\frac{5}{8}$	$1\frac{1}{4}$	2	$\frac{1}{8}$	$\frac{3}{16}$	$3\frac{1}{2}$
$\frac{5}{8}$	$1\frac{1}{4}$	2	$\frac{1}{8}$	$\frac{3}{16}$	4

FIG. 14. — Jig Straps.

and *F*, which have to be determined for each particular case.

The standards which we have described for jigs and jig parts have been used in practice with good results, and the broad principle of such standardization is one that can well receive attention in a shop doing a large amount of tool work.

DIMENSIONING DOVETAIL SLIDES AND GIBS

THE tables, Figs. 15 and 16, were figured for machine-tool work, so as to enable one to tell at a glance the amount to be added or subtracted in dimensioning dovetail slides and their gibs, for the usual angles up to 60 degrees. The column for 45-degree dovetails is omitted, as *A* and *B* would of course be alike for this angle.

In the application of the table, assuming we have a base with even dimensions, as in the sketch Fig. 17, and we wish to obtain the dimensions x and y of the slide, allowing for the gib which we will assume to be ¼ inch thick,

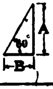
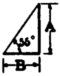
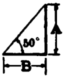
			
A	**B**	**B**	**B**
1/32"	.018"	.022"	.027"
1/16"	.036"	.044"	.053"
1/8"	.072"	.087"	.105"
1/4"	.144"	.175"	.210"
3/8"	.216"	.262"	.314"
1/2"	.288"	.350"	.420"
5/8"	.360"	.437"	.525"
3/4"	.433"	.525"	.629"
7/8"	.505"	.612"	.734"
1"	.577"	.700"	.839"
1 1/8"	.649"	.787"	.944"
1 1/4"	.721"	.875"	1.049"
1 3/8"	794"	.962"	1.158"
1 1/2"	866"	1.050"	1.259"
1 3/4"	1.010"	1.225"	1.469"
2"	1.154"	1.400"	1.677"
2 1/4"	1.298"	1.575"	1.888"
2 1/2"	1.442"	1.750"	2.097"
2 3/4"	1.588"	1.925"	2.307"
3"	1.732"	2.100"	2.517"
3 1/2"	2.020"	2.450"	2.937"
4"	2.308"	2.800"	3.356"
4 1/2"	2.598"	3.150"	3.776"
5"	2.885"	3.501"	4.195"

FIG. 15.—Table for Dimensioning Dovetail Slides.

the perpendicular depth of the dovetail being ⅝ inch, and the angle 60 degrees, we look under column *A* for ⅝ inch and find opposite this that *B* is 0.360 inch, which subtracted from 2 inches gives 1.640 inches, the dimension *x*. To find *y* we first get the dimension 1.640 inches, then looking under the column for 60-degree gibs, find *D* (where *C* is ¼ inch) to be 0.289 inch, which is to be added to obtain 1.929 inches.

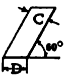
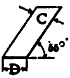
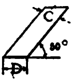
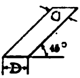
				
C	**D**	**D**	**D**	**D**
⅛"	.144"	.152"	.163"	.176"
3/16"	.216"	.228"	.244"	.264"
¼"	.289"	.305"	.326"	.353"
5/16"	.361"	.381"	.407"	.442"
⅜"	.433"	.457"	.489"	.530"
½"	.577"	.610"	.652"	.707"
⅝"	.721"	.762"	.815"	.883"
¾"	.866"	.915"	.979"	1.060"
⅞"	1.010"	1.667"	1.142"	1.237"
1"	1.154"	1.220"	1.305"	1.414"

FIG. 16. — Table for Gibs.

In practice we usually make this dimension a little larger, say to the nearest 64th, to allow for fitting the gib.

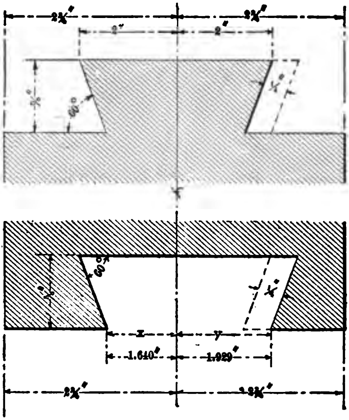


FIG. 17. — Dovetail Slides and Gibs.

HANDLES, BALL-CRANKS AND HAND WHEELS

WHEN a person, before he settles down, forms the acquaintance of a dozen or more machine shops of all denominations and characters, he will notice the chaotic styles and forms of handles, ball-cranks and hand-wheels. Even in one and the same concern, you often find, like all shapes of legs, cabinets, fillets and roundings, every imaginable form of these three simple machine parts.

The handle itself is a very plain machine part. But still it ought to fill the requirements of being easy in your hand; it ought to look well, and all that are made in one shop should be of the same style. It can be comfortable only when the ball part of it rests in the hollow of the hand and all the fingers take hold of it, as is indicated in Fig. 18. It is a bad practice to cut off the pointed end, as shown in the dotted line, which takes away the resting place for the little finger.

One concern makes a handle such as is shown in Fig. 19, and the poor fellow who has to use it wishes the firm could be compelled to monopolize the handling of them. If L, Fig. 18, denotes the length of the handle, good proportions will be obtained by making $d = .38L$, $r = .15d$, $r' = 1.5d$ and $r'' = 1.5d + 1$ inch, and all the other dimensions as indicated on the drawing.

Ball-cranks should, besides having a good appearance, be so proportioned that they as nearly as possible balance from the center hole when the handle is driven into the small ball. As they very often go into places where parts of the machine have to be cleared, it is best to make both ends, measured from the center to the outside of the balls, of equal length. If L is again the length, Fig. 20, $d = .175L + .5$ inch, and $d' = .1L + .5$ inch will give a good appearance and about balance the proportionate handle. The sizes for the shank are indicated on the drawing. These proportions are for drop forgings or cranks made from the bar. While cast-iron cranks never break through usage, many are broken in transit and by accident, and for that reason alone they should be made of steel. Besides, with proper forming tools, they can be produced cheaper than cast-iron ones, and add by their lightness a good deal to the pleasing appearance of the machine.

It is understood that hand-wheels very often have to be designed to suit the conditions, and therefore general rules cannot be very well applied. The dimensions given in Fig. 21, and making $d = .1D + .3$ inch and $r = .2D - \frac{1}{8}$ inch, where D is the diameter of the wheel, give a good

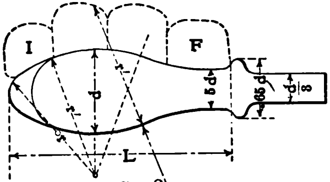


FIG. 18

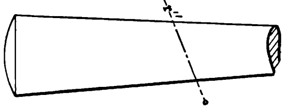


FIG. 19

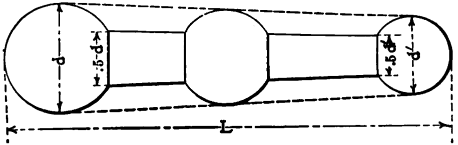
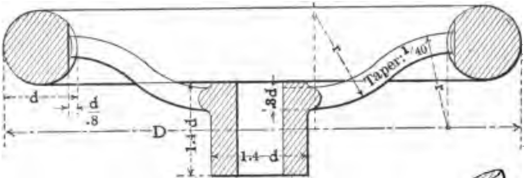


FIG. 20



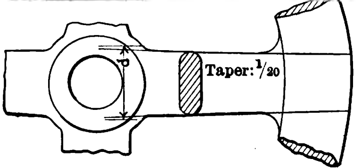


FIG. 21

Proportions for Handles and Hand Wheels.

shape, in the range from 4½ to 12 inches diameter. Of late, the flat or clearance on the inside of the rim, to save hand work in finishing, is often carried to a semicircle. This is very uncomfortable for the hand and looks too much like skimping. Bent arms are often preferable over straight ones and save the knuckles and skin in case a nut or friction knob is applied in the center.

All the dimensions obtained by these formulas rounded off to the nearest sixteenth will answer. These rules are the result of experience and comparison.

MACHINE TOOL HANDLE CHART

In the chart, Fig. 22, the results obtained by working out the formulas for handles as given in the preceding article have been arranged in graphical form.

ANOTHER MACHINE HANDLE STANDARD

The handles in this system are made in strict proportion throughout the set, and are designated

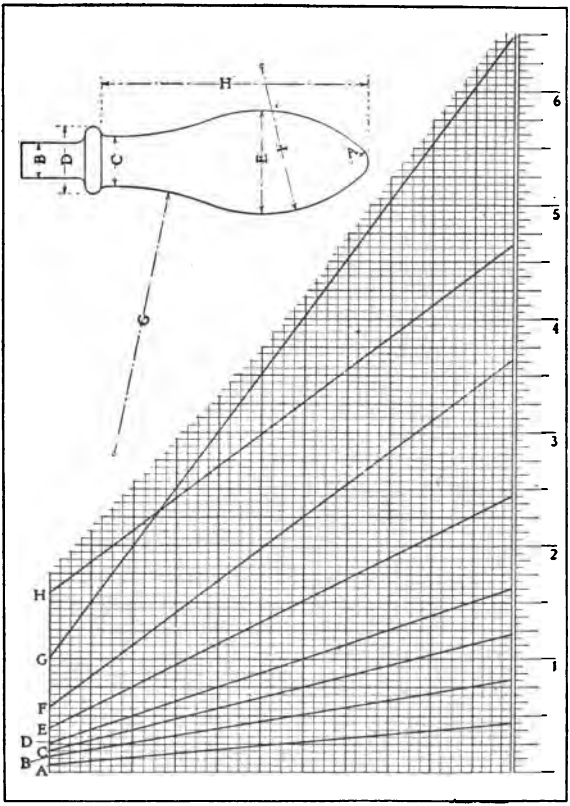


FIG. 22. — Chart for Machine Tool Handles.

by the size of shank or stem, this being the unit in all cases.

Construction lines are shown in Fig. 23 by which the proportions may be traced out. The figures simply designate the proportion of the particular dimension indicated compared with the size of the stem; that is, if the stem is 1 the neck of the handle will be 1, and this neck would be the distance of 1 or the diameter of the shank from the shoulder, the length of the handle

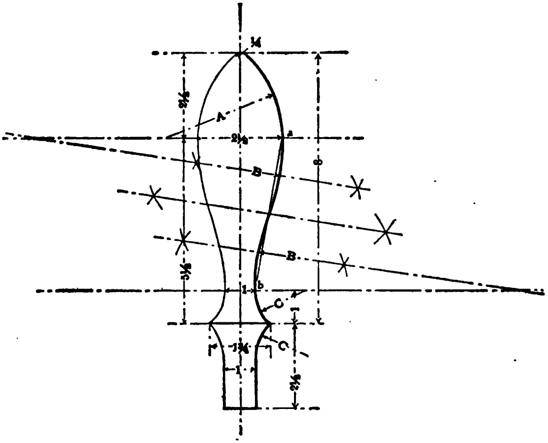


FIG. 23. — Standard Machine Handles.

measured from the shoulder out would be eight times the shank, and so on. If the diameter of the shank is ¼, the other dimensions would be one-fourth of the figures shown, or if it is ½ they would be one-half of the dimensions given, and so on.

The curves are all found with compasses and are simply arcs connecting points and drawn tangent to lines of the circle, the radius *A* being on a line at right angles to the axis passing through the point of the largest diameter and tangent to the small arc at the extreme end of the handle.

To find the radii *B B*, after the swell and neck are located, draw the straight line *a b*, divide it into four equal parts and erect perpendiculars at the points of division. The points where the outer perpendiculars intersect the neck and swell diameter lines extended determine the radii *B B*, which are, of course, equal to one another, the arcs struck with them forming a reversed curve.

Radii *C C* are also equal to one another and are found by placing the dividers on the diameter line of the neck extended, the distance out being such that the arc passes through the point marking the diameter of the shoulder and is tangent to the arc previously struck with radius *B*.

TABLE FOR USE IN LAYING OUT BALL BEARINGS

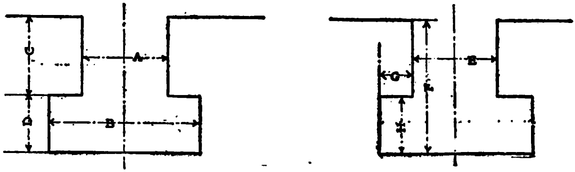
We have had to figure the dimensions for a good many races for ball bearings, and in finding the diameters we have always had to set everything aside and figure the degrees, minutes and seconds in the angle, and then, as it invariably ends in seconds, would have to figure the sine, as all of the tables simply give it for degrees and minutes. After using the above method for a couple of years we decided that we would make a table giving the angles and sines, and thereby do away with a lot of unnecessary work every time that we wanted to find the diameter of a ball race. The second and fifth figures of the sines are figured to the number nearest the half.

N	$\frac{360^\circ}{N}$			$\frac{180^\circ}{N}$			Sin. $\frac{180^\circ}{N}$	N	$\frac{360^\circ}{N}$			$\frac{180^\circ}{N}$			Sin. $\frac{180^\circ}{N}$
	°	′	″	°	′	″			°	′	″	°	′	″	
1	360	0	0	180	0	0	1.	51	7	3	32	3	31	46	.06156
2	180	0	0	90	0	0	1.	52	6	55	23	3	27	42	.06038
3	120	0	0	60	0	0	.86603	53	6	47	33	3	23	46	.05922
4	90	0	0	45	0	0	.70711	54	6	40	0	3	20	0	.05814
5	72	0	0	36	0	0	58799	55	6	32	44	3	16	22	.05709
6	60	0	0	30	0	0	.50000	56	6	25	43	3	12	51	.05607
7	51	25	43	25	42	51	.43388	57	6	18	57	3	9	28	.05509
8	45	0	0	22	30	0	38268	58	6	12	25	3	6	12	.05414
9	40	0	0	20	0	0	.34202	59	6	6	6	3	3	3	.05322
10	36	0	0	18	0	0	.30902	60	6	0	0	3	0	0	.05234
11	32	43	38	16	21	49	.28173	61	5	54	6	2	57	3	.05147
12	30	0	0	15	0	0	.25882	62	5	48	23	2	54	12	.05065
13	27	41	32	13	50	46	.23931	63	5	42	51	2	51	26	.04985
14	25	42	51	12	51	26	.22252	64	5	37	30	2	48	45	.04907
15	24	0	0	12	0	0	.2-791	65	5	32	18	2	46	9	.04831
16	22	30	0	11	15	0	.19509	66	5	27	17	2	43	38	.04758
17	21	10	35	10	35	18	.18375	67	5	22	23	2	41	12	.04688
18	20	0	0	10	0	0	.17365	68	5	17	39	2	38	49	.04618
19	18	56	50	9	28	25	.16454	69	5	13	3	2	36	31	.04551
20	18	0	0	9	0	0	.15643	70	5	8	34	2	34	17	.04486
21	17	8	34	8	34	17	.14904	71	5	4	14	2	32	7	.04423
22	16	21	49	8	10	55	.14233	72	5	0	0	2	30	0	.04362
23	15	39	8	7	49	34	.13616	73	4	55	53	2	27	57	.04303
24	15	0	0	7	30	0	.13053	74	4	51	53	2	25	57	.04245
25	14	24	0	7	12	0	.12533	75	4	48	0	2	24	0	.04188
26	13	50	46	6	55	23	.12055	76	4	44	13	2	22	6	.04132
27	13	20	0	6	40	0	.11609	77	4	40	31	2	20	16	.04079
28	12	51	26	6	25	43	.11197	78	4	36	55	2	18	27	.04026
29	12	24	50	6	12	25	.10812	79	4	33	25	2	16	43	.03976
30	12	0	0	6	0	0	.10453	80	4	30	0	2	15	0	.03926
31	11	36	46	5	48	23	.10117	81	4	26	40	2	13	20	.03878
32	11	15	0	5	37	30	.09801	82	4	23	25	2	11	42	.03830
33	10	54	33	5	27	16	.09506	83	4	20	14	2	10	7	.03784
34	10	35	18	5	17	39	.09227	84	4	17	9	2	8	34	.03739
35	10	17	8	5	8	34	.08963	85	4	14	7	2	7	4	.03695
36	10	0	0	5	0	0	.08716	86	4	11	10	2	5	35	.03652
37	9	43	47	4	51	54	.08510	87	4	8	17	2	4	8	.03610
38	9	28	25	4	44	13	.08258	88	4	5	27	2	2	44	.03569
39	9	13	51	4	36	55	.08047	89	4	2	42	2	1	21	.03529
40	9	0	0	4	30	0	.07846	90	4	0	0	2	0	0	.03490
41	8	46	50	4	23	25	.07655	91	3	57	22	1	58	41	.03446
42	8	34	17	4	17	9	.07473	92	3	54	46	1	57	23	.03414
43	8	22	20	4	11	10	.07300	93	3	52	15	1	56	8	.03378
44	8	10	55	4	5	27	.07134	94	3	49	47	1	54	54	.03342
45	8	0	0	4	0	0	.06976	95	3	47	22	1	53	41	.03307
46	7	49	34	3	54	47	.06825	96	3	45	0	1	52	30	.03272
47	7	39	34	3	49	47	.06679	97	3	42	41	1	51	20	.03238
48	7	30	0	3	45	0	.06540	98	3	40	24	1	50	12	.03205
49	7	20	49	3	40	24	.06407	99	3	38	11	1	49	5	.03172
50	7	12	0	3	36	0	.06279	100	3	36	0	1	48	0	.03141

Table of Sines of Angles of an Equally Divided Circle whose Radius is 1.

T-SLOT DIMENSIONS

The average draftsman thinks his drawing is completely dimensioned when he can copy it without scaling it. In most cases this does *not* give the dimensions in the best way for the workman. T-slots are one of the most common sources of trouble in this respect. Fig. 24 shows the almost universal method. To use this drawing the planer hand has first to add dimensions *C* and *D* to get the whole depth to run down his square-nose tool; then he has to subtract *A* from *B* and divide by 2 to get the distance to cut under. Both these operations involve fractions, and that is where he is lost. Suppose, as in a case recently seen, *B* is $1\frac{9}{16}$ inches and *A* $\frac{7}{8}$ inch; then $\frac{1\frac{9}{16}-\frac{7}{8}}{2}=\frac{11}{32}$. But



Figs. 24 and 25.—T-Slot Dimensions.

can you imagine a shop man figuring this out with a two-foot rule and a lump of chalk, on the floor?

Fig. 25 shows how a planer hand would like the dimensions given. First, he wants to cut down a slot of width *E* and depth *F*, then he picks out a pair of hooking-out tools of width *H* and long enough to cut under *G*. With these he will cut under a distance *G* on each side, and is through with it; and if it is wrong it is easy to tell who made the mistake.

LAYING OFF ANGLES WITHOUT A PROTRACTOR

IN laying off angles on the drawing board there are some short cuts that are not widely known. Of course a protractor can be used or a scale of chords, but this means additions to one's kit, which, while very nice, are expensive; and besides it is a very simple matter to place a mark on a scale that will make it useful as a scale of chords and one that will be right at hand when wanted.

On a decimal scale this is done by assuming 1 inch as the chord of 10 degrees. The radius at which this is true is found by dividing one by the chord of 10 degrees at a radius of 1, as follows:

$$\text{Sin. } 5^\circ = .08715.$$

$$\text{Chord of } 10^\circ = 2 \times .08715 = .1743.$$

$$\frac{1}{.1743} = 5.74' = \text{radius at which one inch is the chord of 10 degrees.}$$

In case it is not desired to use a decimal scale, $1\frac{1}{4}$ or $\frac{10}{8}$ inches can be assumed as the chord of 10 degrees, the radius in this case being:

$$\frac{1.25}{.1743} = 7.22 \text{ inches.}$$

Knowing that 1 inch is the chord of 10 degrees, it is practically accurate to take 1-10 inch as the chord of 1 degree. The error is small, and subdivisions of a degree can be obtained as follows:

1-20 inch = 30 minutes.
1-30 inch = 20 minutes.
1-40 inch = 15 minutes.
1-50 inch = 12 minutes.
1-60 inch = 10 minutes.

In this way pretty close results can be had and in a similar manner subdivisions can be figured for the ordinary scale.

For example, to lay off an angle of 33° 30′, the compass must be set to the radius 5.47 inches and an arc struck. The dividers are then set to the chord of 10 degrees — 1 inch — and three spaces are stepped off. From this point the chord of 3° 30′ remaining is laid off as 7-20 inch. The accuracy of this method is very easily tested by laying out an angle of 60 degrees and working back; it will check if carefully done.

DIVIDING THE CIRCLE

OF course, we all know how to divide the circumference of a circle into 3, 4 or 6 equal parts; but how many can divide it into 5 or 7 without trial spacing? To divide into 5 parts, Fig. 26, draw the diameters $A\ C$ and $D\ E$ perpendicular to each other. Bisect the radius $A\ B$ at G. Set the dividers at G and strike $G\ N = G\ D$, and $D\ N$ is the distance required. To divide into 7 parts, Fig. 27, let $H\ J = H\ K$; bisect $H\ J$ at L, then $K\ L$ is the distance required, very nearly.

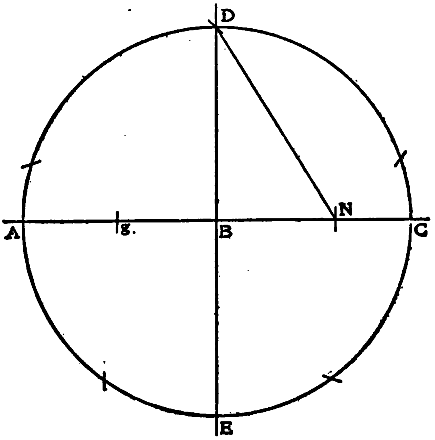


FIG. 26. — Dividing the Circle into Five Parts.

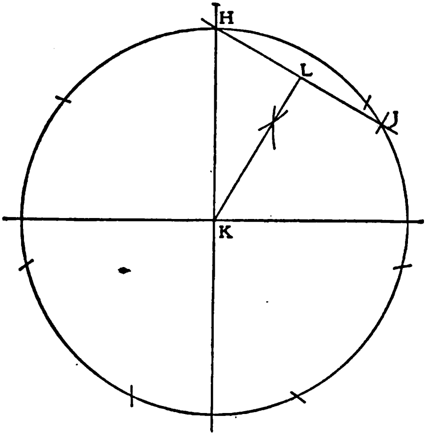


FIG. 27. — Dividing the Circle into Seven Parts.

A TRIANGLE FOR DIVIDING CIRCLES

FIG. 28 is a very handy triangle for draftsmen, patternmakers and others. It is made of No. 14 gage sheet steel, or it may be of wood or other material. The hole marked *B* is for a thumb tack or a needle point. The small holes indicate the number of parts a circle may be divided into. Hole marked 5 is 72 degrees, hole marked 6 is 60 degrees from edge *A*, and so on. Fig. 28 shows the method of using the instrument for dividing a circle into five parts.

A SIMPLE METHOD OF FINDING THE AREA OF IRREGULAR FIGURES

ALTHOUGH there are a great many ways of finding the area of an irregular figure, it is often a great advantage to know a very simple way by which one can form a close approximation.

Suppose that it is required to find the area of the figure given in Fig. 29. To do this we make a tracing on some thin paper and fold it along the line 2—2, adjusting it so that the areas on each side balance one another, the position when

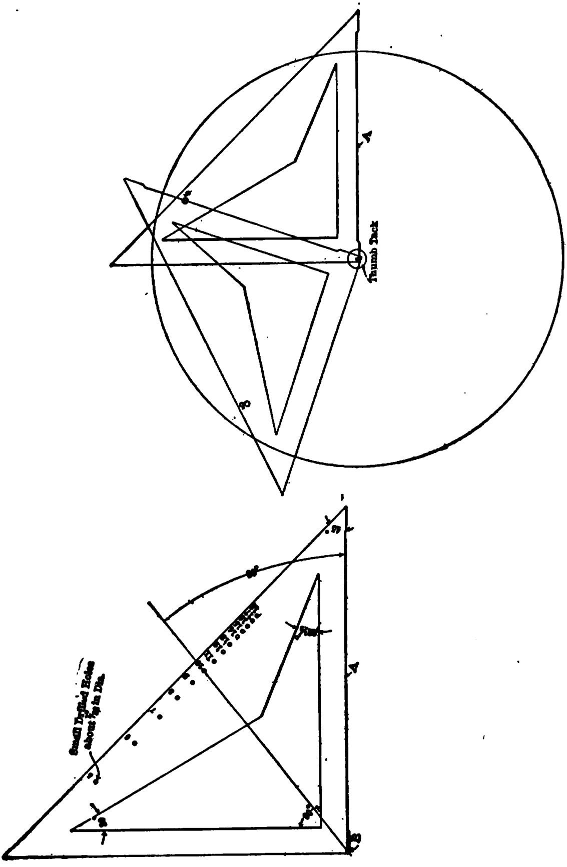
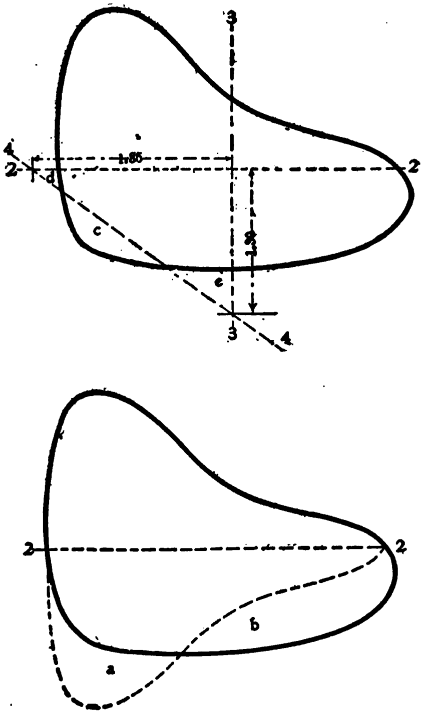


FIG. 28. — A Triangle for Dividing Circles.

folded being shown in Fig. 30, in which as nearly as may be area *a* = area *b*. Next we open the tracing and fold it along the line 3—3, again



FIGS. 29 and 30.—Finding Area of Irregular Figures.

adjusting it so that the excess and deficiency areas of the lower half balance one another, the result being that each section of the lower half represents one quarter of the original area and it only remains to find the area of one of these sections and multiply it by four to obtain the total area. This can readily be done by adopting the same principle and folding the paper on the line 4—4, making area c = area d + e and giving the equivalent triangle.

In the example given the two sides of the triangle measure respectively 1.85 and 1.30 inches. Instead of multiplying the area of this triangle by four we multiply the two dimensions together and then multiply by two, which will of course give the same result:

$$1.85 \times 1.30 = 2.4050$$
$$2.4050 \times 2 = 4.81$$
= area of original figure in square inches.

If the tracing is made on squared paper no scale will be needed and the calculation can be easily and rapidly made.

It will be noticed, of course, that the lines do not divide the whole figure into four equal parts, but divide one half into two equal portions. The upper half would have to be balanced in a similar way if a check was considered necessary.

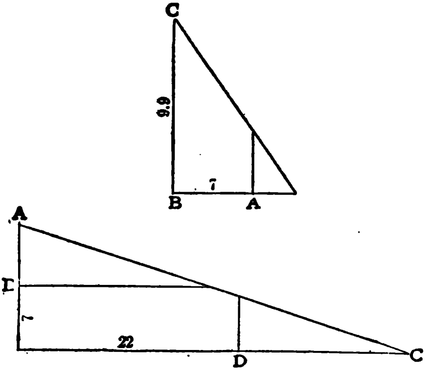
We have compared the areas obtained by this simple method with those obtained by ordinates, triangles and the planimeters and find in all cases that a very close approximation is obtained.

SOME ARITHMETICAL SHORT CUTS

It is likely there are some readers who are not quick at mathematics or expert with the slide rule, and who occasionally have to determine results and are ready to adopt any short cut that will help them out.

There are short cuts that are not absolutely correct, and whether they should be used or not depends upon whether the result is as accurate as is required. The relation of the side of a square to its diagonal is approximately as 7 to 10, that is, it is within a small fraction; and whenever this ratio is used to determine a measurement on a drawing, such as the diagonal of a ⅞-inch square bolt head, and the resulting 1¼ inches is nearer than the draftsman can work, or needs to work, the short cut is good enough. So, too, the circumference of a circle is as 22 to 7 within 0.00001, which is far within the limits of a draftsman's ability to work, and probably far more accurate than can be obtained by the slide rule. These ratios, that is, 7 to 10 (or almost exactly 7 to 9.9) and 7 to 22, permanently drawn on a draftsman's drawing board (see Figs. 31 and 32), enable him to instantly determine the circumference of any circle within the range of the diagram or the diameter of any circle of which he has the circumference, or, from the other triangle, to determine the distance across the corners of any square within its range.

That is to say, if he wishes to know the distance across the corners of a 2¼-inch square he has only to measure off from the foot of the diagonal, as at *A*, Fig. 31, 2¼ inches, strike the vertical parallel to the original line *B C* and the length of the new line is the distance required. In the case of the circumference of the circle, if the diameter is laid off from *A*, Fig. 32, down the vertical, as at *B*, and the horizontal parallel to the base is drawn through *B*, the length of the new line is the required circumference; or, if the circumference is known and the diameter is required, measure the circumference from *C* on the base line, as at D, strike the vertical and its length is the diameter. A second advantage in these diagrams is that, no matter what the measure or how fine the fraction, the result is obtained just as readily as with whole numbers, whereas, with the slide rule, everything is in tenths.



Figs. 31 and 32. — Arithmetical Short Cuts.

When the measure wanted is small in proportion to the triangle, it is only necessary to use large units for the small ones needed. In making drawings to scale, say one quarter size, we use small units to represent large ones, and in this case we can reverse the thing and use large units for small ones.

FACTORS OF "PI"

MANY attempts have been made to prove by different processes of reasoning that the ratio of the diameter to the circumference of a circle is 1 to 3.2, and not, as we know and accept it, 1 to 3.14159, but without apparent success. How much simpler this value would be if only it were correct, and how many of our calculations would be made easy! And yet the generally adopted value, 3.1416, should not be so much despised, as it is not so terribly unmanageable, but is divisible by more than sixty different numbers without leaving a remainder.

The number 3.1416 is the product of $2 \times 3 \times 4 \times 7 \times 0.11 \times 0.17$, from which we obtain the various divisors of 3.1416 which leave no remainder, given in Table 1. The knowledge that these divisors exist may often simplify a calculation and enable a fraction, having 3.1416 for the divisor or for the dividend, to be quickly reduced to much simpler terms; thus, $\frac{3.1416}{231} = 0.0136$, where 231 is the number of cubic inches in a United States gallon, while $\frac{136}{3.1416}$ reduces at once by means of the table to $\frac{1}{0.0231}$.

It may also be noted that 3.1416 divided by 5,280 (the number of feet in a mile) gives 0.000595, without remainder.

TABLE 1 — FACTORS OF 3.1416.

3.1416 DIVIDED BY

2 = 1.5708	68 = 0.0462	561 = 0.0056
3 = 1.0472	77 = .0408	616 = .0051
4 = 0.7854	84 = .0374	714 = .0044
6 = .5236	88 = .0357	748 = .0042
7 = .4488	102 = .0308	924 = .0034
8 = .3927	119 = .0264	952 = .0033
11 = .2856	132 = .0238	1,122 = .0028
12 = .2618	136 = .0231	1,309 = .0024
14 = .2244	154 = .0204	1,428 = .0022
17 = .1848	168 = .0187	1,496 = .0021
21 = .1496	187 = .0168	1,848 = .0017
22 = .1428	204 = .0154	2,244 = .0014
24 = .1309	231 = .0136	2,618 = .0012
28 = .1122	238 = .0132	2,856 = .0011
33 = .0952	264 = .0119	3,927 = .0008
34 = .0924	308 = .0102	4,488 = .0007
42 = .0748	357 = .0088	5,236 = .0006
44 = .0714	374 = .0084	7,854 = .0004
51 = .0616	408 = .0077	10,472 = .0003
56 = .0561	462 = .0068	15,708 = .0002
66 = .0476	476 = .0066	5,280 = .000595

Similarly $\frac{\pi}{4}$ or 0.7854 (which, multiplied by the square of the diameter of a circle, gives its area) is the product of the factors $2 \times 3 \times 7 \times 0.11 \times 0.17$, and is divisible, without remainder, by thirty numbers, as shown in Table 2.

TABLE 2—FACTORS OF .7854.

0.7854 DIVIDED BY

2 = 0.3927
3 = .2618
6 = .1309
7 = .1122
11 = .0714
14 = .0561
17 = .0462
21 = .0374
22 = .0357
33 = .0238
34 = 0.0231
42 = .0187
51 = .0154
66 = .0119
77 = .0102
102 = .0077
119 = .0066
154 = .0051
187 = .0042
231 = .0034
238 = 0.0033
357 = .0022
374 = .0021
462 = .0017
561 = .0014
714 = .0011
1,122 = .0007
1,309 = .0006
2,618 = .0003
3,927 = .0002

In conclusion, it may be of interest to some to remember that the ratio 113: 355 is more exact than the ratio 1: 3.1416, and is of easy use with the slide rule, although we use its double, 226: 710, because there are positive lines on the rule and slide for these figures, which can be set exactly opposite each other, thus eliminating all errors which might arise from guessing or estimating their position.

The value of 113: 355 to seven places of decimals is 3.1415929, while the value of π is 3.1415926 equivalent to a difference of about 1 inch in 150 miles, which it seems to us will never be appreciated on this globe.

MULTIPLYING BY .7854

THE interesting number of factors into which the commonly used value of Pi can be split, as just given, may derive additional interest from the short method of multiplication given below. It sometimes occurs that tables are not available when needed, and if we can reduce the labor of such a mechanical operation as multiplication, we minimize the chances of error.

When finding the area of a circle in the usual way four multiplications are required, one for each digit. The following method requires only one.

Example: To find the area of a circle of 3.7 inches diameter.

$$3.7 \times 3.7 = 13.69$$

$$\begin{array}{rr}
 & 13.69 \\
 & \underline{.7854} \\
 & 9583 \\
 & 9583 \\
 & 19166 \\
 & \underline{19166} \\
\text{Area} = & 10.752126
\end{array}$$

Multiply top line by seven, repeat one place to the right, double the above, repeat as before.

Proof of the foregoing:

$$\begin{array}{r} 7 \\ 7 \\ 14 \\ 14 \\ \hline 7854 \end{array}$$

If the proof only is memorized, the method is fixed in the brain forever.

THE ADDITION OF BINARY FRACTIONS

Nothing surprises one more when going into drafting rooms than to find draftsmen laboriously adding dimensions given in binary fractions by the use of their thumb nails on a drafting scale or, in some cases, by reducing to a common denominator after the regulation method with vulgar fractions in general.

Binary fractions form a class by themselves and have little in common with vulgar fractions in general, except the form in which they are written. The school arithmetics do not recognize this difference, nor, indeed, do they even recognize the name by which these fractions are known, and the result is that each individual is left to discover their properties himself and this, apparently, few do.

As a matter of fact, except in the manner in which they are written, binary fractions are much more closely related to decimal than to vulgar fractions. The essential principle of decimals is that each denomination bears a fixed ratio to those preceding and following it, and this is precisely the principle of binary fractions. In the case of decimals the ratio is 10, while in the case of binary fractions the ratio is 2. Just as $\frac{1}{100}$ is one-tenth of $\frac{1}{10}$ and $\frac{1}{1000}$ of $\frac{1}{100}$, so $\frac{1}{8}$ is one-half of $\frac{1}{4}$ and $\frac{1}{16}$ of $\frac{1}{8}$. This identity of principle is obscured by the fact that the decimal system of notation leads to different methods of expressing these quantities. Were our system of notation based — as it is the pity of pities it is not — on 8 instead of 10, binary fractions would be expressed as decimals are now, showing that the difference between our usual methods of writing them is not in their nature, but is an outgrowth of our system of notation.

Even written as they are, the addition of these fractions usually requires less effort and is just as simple, mentally, as the addition of decimals, and, as might be expected from their similarity, the addition of the two classes is exactly alike in principle, except that, when adding decimals, we divide by ten after each partial addition, while, in adding binary fractions, we divide by two. The quotient after each division is carried to the next partial addition and the remainder is set down as a part of the answer, in exactly the same way in both cases, the difference being that with binary fractions half the time we have no remainder, and when we do have one it is always 1, whereas with decimals we have a remainder 9 times in 10 and it may be anything between 1 and 9 inclusive.

The binary fractions possess a positive advantage when adding them horizontally, as they commonly appear on a drawing, as there is no difficulty in picking out the right figures, the denominators forming a positive guide and making mistakes in this respect almost impossible; and there is hence no necessity for those who shy at horizontal addition writing the quantities in a column, which many do for safety when adding decimals.

Like all arithmetical processes, this seems far more laborious and involved in the explanation than in the fact. With a small amount of practice it becomes instinctive as with ordinary addition. We do not realize how many mental efforts we make in ordinary addition and perhaps there is no better way to illustrate the simplicity of the method to be described than to perform the operation on the same quantities expressed both in binary and in decimal fractions. For this purpose let us take the following illustration, which is certainly as serious a one as the draftsman often has to deal with:

$$4\tfrac{3}{8} + 3\tfrac{1}{4} + 4\tfrac{7}{16} + \tfrac{3}{32} + 2\tfrac{5}{32} + 1\tfrac{9}{16} + \tfrac{9}{32} + 2\tfrac{3}{4} = ?$$

In order to point out the identity of the mental processes when adding binary and decimal fractions, let us first perform in detail the addition of these quantities expressed as decimals, omitting, however, all figures beyond the third decimal place in order not to be pedantic and also to avoid an unduly labored explanation.

Expressed in decimals the problem becomes:

$$4.375 + 3.25 + 4.437 + 0.094 + 2.156 + 1.562 + 0.281 + 2.75 = ?$$

Adding the thousandths we have:

$$5 + 7 + 4 + 6 + 2 + 1 = \frac{25}{1000} = \frac{2}{100} + \frac{5}{1000}$$

the 5 forming part of the answer and the 2 being carried to the hundredths thus:

$$2 + 7 + 5 + 3 + 9 + 5 + 6 + 8 + 5 = \frac{50}{100} = \frac{5}{10} + \frac{0}{100}$$

the 0 forming part of the answer and the 5 being carried to the tenths column thus:

$$5 + 3 + 2 + 4 + 1 + 5 + 2 + 7 = \frac{29}{10} = 2 + \frac{9}{10}$$

Proceeding as before with the whole numbers we have:

$$2 + 4 + 3 + 4 + 2 + 1 + 2 = 18$$

and, annexing the several remainders to the final 18, we have for the answer,

$$18 + \frac{9}{10} + \frac{0}{100} + \frac{5}{1000} = 18.905$$

Taking up now the binary fractions, we proceed in exactly the same way, beginning with those having the largest denominator — 32. Adding these we obtain:

$$3 + 5 + 9 = \tfrac{17}{32} = \tfrac{8}{16} + \tfrac{1}{32}.$$

the $\tfrac{1}{32}$ forming part of the answer and the $\tfrac{8}{16}$ being carried to the sixteenths, which are next added, thus:

$$8 + 7 + 9 = \tfrac{24}{16} = \tfrac{12}{8} + \tfrac{0}{16}$$

the $\tfrac{0}{16}$ forming part of the answer and the $\tfrac{12}{8}$ being carried to the eighths, which are then added, thus:

$$12 + 3 = \tfrac{15}{8} = \tfrac{7}{4} + \tfrac{1}{8}$$

the $\tfrac{1}{8}$ forming again part of the answer and the $\tfrac{7}{4}$ being again carried to the fourths thus:

$$7 + 1 + 3 = \tfrac{11}{4} = 2 + \tfrac{3}{4}$$

Proceeding as before with the whole numbers we have

$$2 + 4 + 3 + 4 + 2 + 1 + 2 = 18$$

and, annexing the several remainders to the final 18, we have the answer

$$18 + \tfrac{3}{4} + \tfrac{1}{8} + \tfrac{0}{16} + \tfrac{1}{32} = 18\tfrac{29}{32} \text{ or } 18\tfrac{7}{8} + \tfrac{1}{32}$$

as we prefer to express it on the drawing.

A glance back over the process will give us a new respect for the simplicity of binary fractions, for, counting up the partial additions that have been made in summing both kinds of fractions, we find a total of 7 in the case of the binary and 20 in the case of the decimals. What the average ratio is would not be easy to determine, but it will usually be found in favor of the binary factions and heavily so when, as in this case, the decimals are the equivalents of binary sizes.

The draftsman who will become familiar with this method by a little practice will never go back to the thumb-nail-and-drafting-scale plan again.

HOW TO FIND THE UNKNOWN FIGURE ON DRAWINGS

THE illustration Fig. 33 represents a nest of figures such as one often strikes on drawings. It will be seen that the dimensions are given at all places except that shown at *x*, which we will suppose is a very important dimension, as for instance the distance from one planed surface to another. The scheme is to start at one extremity of *x* and go up or down, and note the dimensions, one after the other, in two columns, placing all

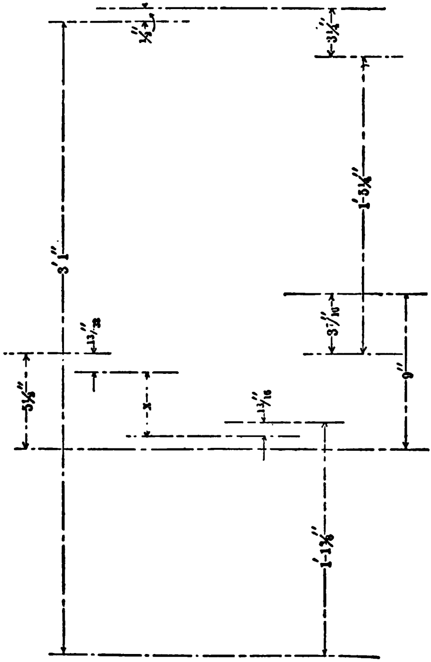


FIG. 33. — How to Find the Unknown Figure.

the dimensions going up in the + column and all those going down in the − column. The [illegible] the − and the − columns will [illegible]

We will begin with the lower extremity of x and [illegible] taking one figure after the other, we have [illegible] − [illegible] − [illegible] − [illegible] − [illegible] − $3\frac{1}{16}$, and so on as arranged in the following columns:

−	+
[illegible]	x
[illegible]	$\frac{13}{32}$
[illegible]	9
[illegible]	1′ − $5\frac{1}{4}$
[illegible] − [illegible]	$3\frac{1}{4}$
[illegible]	1′ − $1\frac{3}{8}$
[illegible] − [illegible]″	3′ − $7\frac{3}{32}$″
[illegible] − [illegible]	

Hence x = [illegible]

When the dimensions run horizontally, the method is the same. The − sign represents dimensions going to the right and the − sign those to the left.

This little method will save a wonderful amount of time and energy, not only for the machinist, but for the draftsman and the engineer as well.

DRAWING HEXAGON NUTS

One of the most difficult things for the ordinary draftsman to make sightly is the top view of the elevation of a hexagon nut, particularly if the drawing is to a small scale. The best way to draw the top view of the nut is as shown

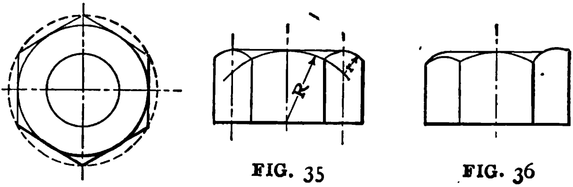


FIG. 34 FIG. 35 FIG. 36

Drawing Hexagon Nuts.

in Fig. 34. The sides of the nut are drawn tangent to the inner circle. Too many draftsmen attempt to draw the sides to the outer circle indicated by dotted lines. This almost always results in making the drawing lop-sided. An elevation of the nut where the drawing is anyways particular as to appearance should be made as in Fig. 35. Make the radius *R* equal to the distance between the two sides of the middle flat. Usually this will be the hight of the nut.

Continue the circle in the pencil drawing until it crosses the lines running through the centers of the side flats. This will give the center of the radius *r* for the smaller circles. Always take pains in a drawing of this kind to measure off for the center lines of the side flats, otherwise the elevation is very apt to look like that shown exaggerated in Fig. 36.

AN INSTRUMENT FOR DRAWING OUTLINES OF IRREGULAR OBJECTS

THERE are many occasions when a draftsman must obtain a correct projection of objects having an irregular outline; as, for instance, the stock of a firearm, various other gun parts, sewing-machine parts, bicycle tube connections, and the like. Some draftsmen, in order to draw such outlines, cut gages from cardboard or resort to various other expedients equally slow and tedious.

The drawing, Fig. 37, shows a sectional elevation and a plan of an instrument designed some time ago to overcome the difficulty of delineating such objects quickly and with precision, and while there may be some room for improvement in its general appearance, its work is very satisfactory.

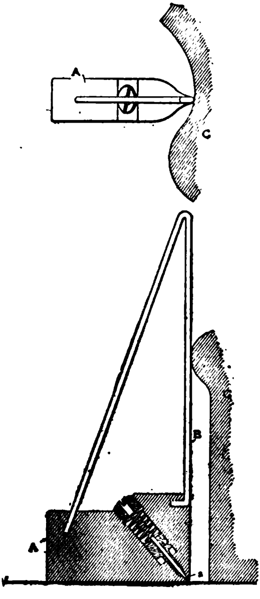


FIG. 37.—Instrument for Drawing Object of Irregular Outline.

The block of steel *A* is finished to a wedge shape at the front end, the front edge being perpendicular to the bottom. A piece of stiff wire bent to an angular shape has its ends inserted in holes in the block and soldered firmly therein, so that the part *B* is perpendicular to the bottom of base *A* and forms a continuation of the front edge of the base while the sloping part forms a brace for the upper end of the wire. The width of the base block must be sufficient to keep the instrument perpendicular when moved sidewise.

The hole, formed in block *A*, passes obliquely downward to the corner *a* and is counterbored to receive a pencil carrier which moves freely in the hole but without play enough to impair accuracy, and which carries a pencil lead secured by a tiny set-screw. The point of the lead normally projects through the hole at *a*, the holder being pressed downward by a spring backed up by an adjusting screw.

To operate the instrument, it is placed on the paper as indicated, with the edge *B* against the object *C* to be traced, and then moved carefully around the outline, care being taken that the front edge is always at right angles to a tangent at the point of contact on the object, as illustrated in the plan.

A LETTERING GAGE

THIS gage, Fig. 38, is made of machinery or tool steel about $\frac{1}{32}$ inch thick. A paper disk is shellacked on each side, marked as desired

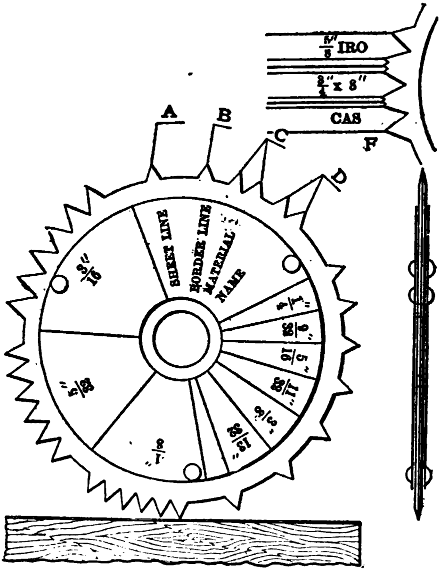


FIG. 38. — A Lettering Gage.

with waterproof ink and then shellacked on the outside to keep clean. The three escutcheon pins are not to keep the paper in place, but to make it easy to pick up. It is universal with the exception of the portion *A B C D*, which varies with the practice of every office. It is useful for lettering and for making tables. To use the gage for marking a drawing where the paper or cloth is cut to size, place *A* on the edge of the sheet and mark off the distance from *A* to *B* by pressing lightly on the paper, except at the bottom of the sheet where you allow the gage to rotate between the thumb and forefinger until you have *B*, *C* and *D* marked off. For ordinary work, as lettering on detail sheets, use the $\frac{1}{8}$ or $\frac{5}{32}$ inch space as you desire. For table work, repeat until you have the sheet ruled off. If you do much table work, you can make the gage with first a small space, then the hight of the letter and then the small space again, as shown at *F*. The light lines are pencil lines and the heavy are those that space the sheet off. The beauty of this gage is that it does not punch a hole in the paper, but makes an impression in it which can be readily seen. The gage is about 2½ inches outside diameter, with a ⅜-inch hole in the center.

ANOTHER LETTERING GAGE

THE type of gage shown in Figs. 39 to 43 consists of a small piece of rectangular bar steel, with a series of parallel grooves cut in one face, and the ends beveled off, as shown, after which the piece is hardened and tempered. When the points become dull from use, the gage may be sharpened, as shown in reduced scale in Fig. 42, by laying it on its side on the table of a disk grinder, and grinding the beveled face. The gage is held as in Fig. 43 when in use, *D P* representing the drawing paper.

The spaces for which the gages are made, are to a large extent a matter of taste with the user. The gage we have like Fig. 39 is made with $\frac{1}{16}$ inch spaces, and can, of course, be used for laying off both the horizontal and vertical guide lines. Fig. 40 has the lower space $\frac{1}{16}$ inch wide and the upper space $\frac{1}{32}$ inch. Fig. 41 has the outer

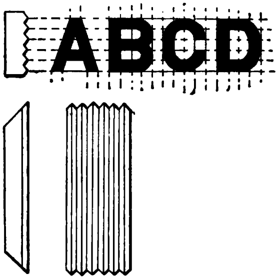


FIG. 39

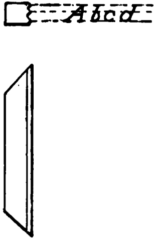


FIG. 40

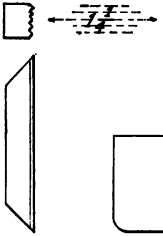


FIG. 41

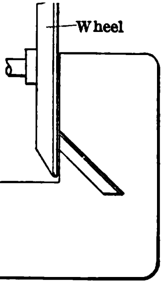


FIG. 42

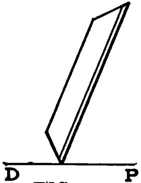


FIG. 43

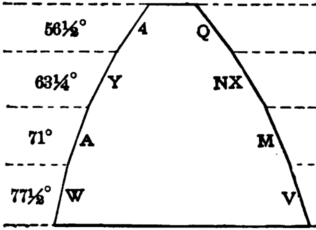


FIG. 44

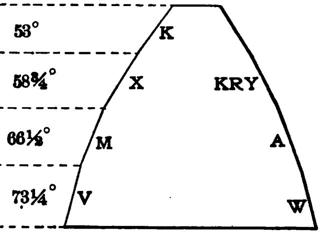


FIG. 45

Another Lettering Gage.

spaces $\frac{1}{32}$ inch each, while the two inner spaces are $\frac{3}{64}$ inch each.

In making the V notches in these steel pieces use a double bevel milling cutter, 45 degrees each side. Of course, Fig. 39 is a simple job of milling, but with the gages Figs. 40 and 41 you have to exercise your head a little to get the tops of the ribs all in the same plane. The ultimate spacing you are after is that between the tops of the ribs, while the cross-slide of the milling machine has to be moved the distance between the *bottoms* of the grooves. However, the vertical and horizontal adjustments of the milling machine are easily arrived at by remembering that the depth of any 90-degree groove is equal to half its width, while the distance between the bottoms of two adjacent grooves is equal to half the sum of their respective widths.

Another handy device for use in making the style of letters shown in Fig. 39 is a letter templet for the straight parts of the letters that are neither vertical nor horizontal. The one we have is shown in Fig. 44 and reversed in Fig. 45. It is made of sheet aluminum, although this is far from being an ideal material for that purpose. One objection to the celluloid that triangles are usually made of is that in this case the transparent feature might prove objectionable, as the templet is marked on both sides, and the marks on the side against the paper would show in a reversed direction. In the case of *A*, *M*, *V*, *W*, *X* and *Y* this objection would not hold good, but with the *K*, *N*, *Q*, *R* and 4 it might be confusing to have a transparent templet. The vertical hight of each slope should be somewhat more than the hight of the largest size of letters intended to be laid out with it. The angles on this templet are based on the supposition that all the letters calling for its use are 4 units wide (the hight being 5 units) with the exception of *A*, which is 4½ units wide, *M* 5 units wide, and *W*, which is 5½ units wide. Any other proportion of width to hight would, of course, make different angles necessary.

A COMBINATION TRIANGLE

THE sketch, Fig. 46, shows a combination triangle which has been used for some time, and with the protractor added it is still more useful.

With the ordinary triangle one is constantly turning it over to get opposite angles, but with the one shown it is unnecessary, as one can get the opposite angle to both the 60 and the 45 degree edges from the angles in the center. It

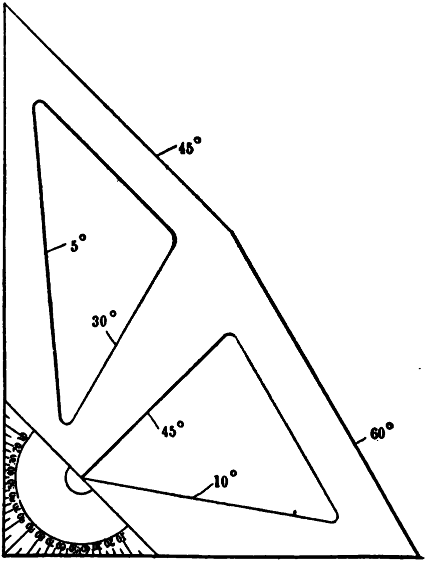


FIG. 46. — A Combination Triangle.

also has a few more useful angles added, which are very often required, such as 5, 10, 15 degrees, etc.

HANDY DRAWING INSTRUMENT

At the works of The Straight Line Engine Company they have evolved the handy little device shown in Fig. 47. It is for drawing round corners and fillets of various sizes, and for those purposes it is far more convenient than compasses; radii are marked, the outside ones made enough smaller and the inside ones enough larger so that corners when drawn with a pencil or inking pen will be the size indicated. They can be of various other radii, and if the

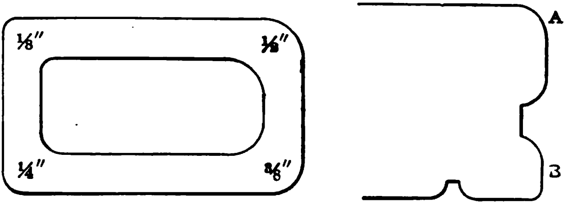


FIG. 47 FIG. 48

A Handy Instrument.

draftsman wishes to mark what the radius of his curve is, he has the figures before him.

The instrument may be of any sheet metal nickel-plated or of celluloid, and if $\frac{1}{16}$ inch thick, beveled on one side, used flat side down for the pencil and the other side for the inking pen, it will be found a great convenience.

Fig. 48 shows its application, the curves *A* and *B* being drawn by using the outside corners and the others by using the inside.

A GRADUATED CURVE FOR DRAFTSMEN AND PATTERNMAKERS

IN a certain drafting room the irregular curve is quite an important tool, but a difficulty which was ever present in the pattern department was for the patternmaker to get a duplicate of any curve (irregular) which appeared on a drawing. After a trip to the draftsman to get the curve which was used, it usually took from ten to fifteen minutes to pick out the right one. This inconvenience and loss of time suggested the idea of which the sketch Fig. 49 is explanatory. We accordingly had procured for the pattern department a set of curves the same as those used in the drafting room, and graduated and numbered them as shown. The method now used is to specify between two points on any curve on a drawing between exactly what graduations the curve was drawn, as "From 2⅛ to 8¾, Curve

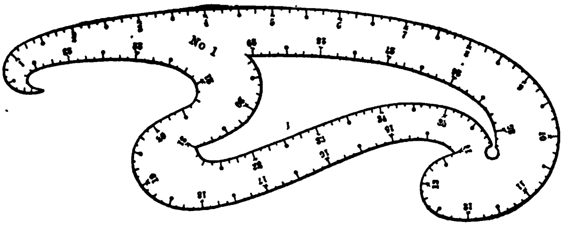


FIG. 49. — A Graduated Curve.

No. 1." This overcomes all difficulties in our case, but a still better plan for the average draftsman is to have the curve graduated alike on both sides, so as to be able to reverse it in order to put the same curve on each side of a center line. Most draftsmen, after drawing a curve, mark the curve on the edge so as to be able to reverse it, but the graduations are better.

FINDING THE CENTERS OF FILLETS AND CORNERS

EVERY draftsman has some home-made tools. Fig. 50 shows two views of one which has been found a time-saver where many round corners are required on a machine. The tool consists of the body *A*, in which a hole is drilled to fit a compass needle point. The button *B* is driven on the upper end of the needle point, and a coiled spring *C* is placed between the body *A* and the button *B* to keep the needle point off the paper when not in use. The lower part of the illustra-

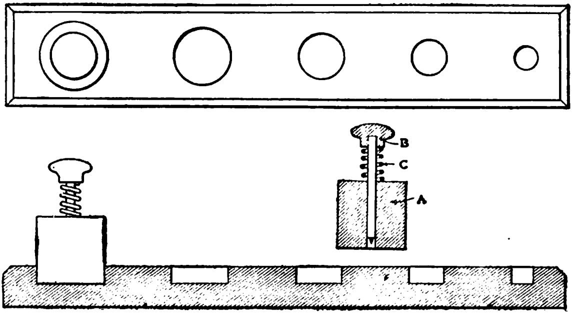


FIG. 50.—Tool for Finding Centers of Fillets and Corners.

tion shows a wooden base for holding a set from ¼ to ¾ inch diameter, advancing by eighths.

The method of using is as follows: The body *A* is held by the thumb and middle finger and is placed tangent to the lines to be connected by the arc of a circle — generally, of course, a quadrant; then the needle point is forced into the paper by the forefinger, locating the required center. After locating the centers for all corners the arcs are drawn in the usual manner.

AN INSTRUMENT FOR DRAWING SCREW THREADS

We believe that the simple device Fig. 51, for laying out screw threads, will be interesting to draftsmen who do not like to do this kind of work and who are justified in using conventional forms wherever possible: File a series of 60-degree notches in a triangle, making the width at the top equal to 1 inch divided by the pitch and leaving a small point to stop the pencil. We use, 4, 6, 8, 10, 12 and 16 pitch, making the notches ¼, ⅙, ⅛, 1/10, 1/12, and 1/16 inch wide. To use the instrument, place the pencil against the left side of the notch, run down that side and up the other to the stop; then move the triangle along

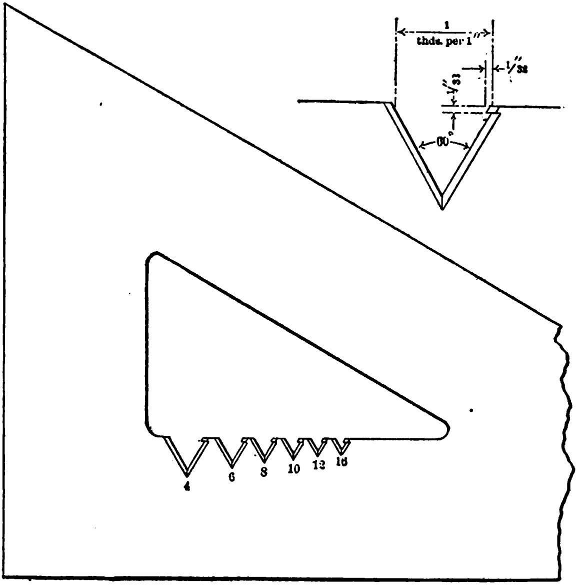


Fig. 51. — An Instrument for Drawing Screw Threads.

to the right until the pencil is again against the left side; repeat as many times as desired. A uniform, rapidly made thread results.

AN ERASING MAÇHINE

THE drafting department of the Laclede Gas Company, St. Louis, keeps records of streets, plat books, insurance books, main records, etc., and as these records must be continually changed on account of new pipes being laid in place of old ones, there is a great deal of erasing to be done.

To reduce the large amount of time and work necessitated in erasing by hand and yet permit of the work being done carefully, the following scheme was devised to do this erasing mechanically.

An ordinary dental engine, such as is used by dentists for drilling teeth, was procured, and a circular ink eraser attached to the chuck by means of a small screw. The flexible shaft to which the eraser is attached allows considerable movement, and all the draftsman has to do is to guide the eraser by means of the handle. Anyone trying this machine should watch the following points:

Keep the machine at a good speed, and do not press the eraser too hard into the paper, as it erases very rapidly. It will be found that a good paper will take on a hard surface at the erased place and the erasure will be hardly noticeable.

Erasing can be done with this machine in about one-tenth the time it would take to do it by hand; besides it is not tiring to the draftsman.

STOPPING OUT TRACINGS FOR BLUE-PRINT TABLES

A MORE convenient method than blacking a tracing with ink is here suggested, when tables are to be made on blue-prints and the squares are wanted white for filling in:

Take a piece of paper that will not print through (yellow or buff paper). Cut it to the size of table required, and perforate the rulings as required with a dressmaker's pattern tracing wheel, placing the paper over three or four thicknesses of blotting paper. The width of the lines may be varied by the pressure on the wheel. After perforating, take very fine sand-paper and remove the burr from the back side to insure clean holes when printing. Fasten with mucilage or rubber cement, by the corners, to the tracing, and the blue-print will be white with dotted blue lines according to the perforations.

MARKING BLUE-PRINTS

NEARLY everyone who handles blue-prints finds at times that he would like to make additions or corrections to change a dimension here and there or add notes. Occasions come up every day. There are several ways to make these corrections, several wrong ways and one right one. Some people mark the print with a lead pencil and some use ink, but any combination of black on blue is scarcely noticeable. It has become the custom, therefore, to use a soda solution, using it as ink, and the result is a white line not very different from the print. The soda on the surface of the paper collects dirt and the lines fade and lose their original intensity.

A good way is to write your figure in ink — ordinary Carter's or any other fluid that is acid-proof — then take your ruling pen and put a blot of soda over the spot. This whitens the back ground and turns the ink jet black, and it is done in half the time and twice as nicely as any other way. The white spot is there to stay and the ink will never fade.

THE BLUE-PRINT PROCESS AS AN ADJUNCT TO THE TYPEWRITER

It very often happens that a number of copies are wanted of a specification, notice or some other paper, a mimeograph or hectograph is not at hand, too many copies are desired to permit of manifolding, and it is not desirable to go to the expense of printing. In such a case the matter can be written out by a typewriter, a piece of carbon paper being put in back of the sheet, so that the printing is given density by being on both sides of the paper. This sheet is then used to make blue-prints from in the usual manner. Thin manifolding paper should be used; the grade called unglazed onion skin gives the best results. After prints have been made the sheets can be filed for future use, if desired.

If white prints are wanted, new carbon paper can be used and the prints made from that, the letters in this case appearing on a white ground, and while this has a handsome appearance, carbon paper is not as cheap as white paper.

PREPARING TRACING CLOTH

Many draftsmen use the dull side of the tracing cloth or prepare the smooth side by rubbing with chalk dust. A much better way is to use the smooth side and wash it thoroughly with alcohol by means of a piece of soft cloth or cotton waste. The alcohol does not soften the tracing cloth at all. It does not even destroy the gloss, but cuts it enough to make it take the ink perfectly. The advantages over the chalk method are: First, cleanliness, no dust left to clog the pen; second, it takes out the curl, so that when the tracing is removed from the board it will lie perfectly flat; third, it shrinks the cloth slightly, so that after drying, which takes but a few seconds, it will be stretched tight and smooth over the drawing.

PHOTOGRAPHING BLUE-PRINTS

In photographing blue-prints the print is first placed in a tray containing a dilute solution of ammonia, say about 5 per cent. strong aqua ammonia in water, upon which the blue color will slowly fade, disappearing altogether in the paler portions, and remaining a faint pink in the deeper parts.

After the blue color is entirely gone the print should be washed well in clean water, and then placed in a tray containing a weak solution of tannic acid, whereupon the whole detail of the print will return in a non-actinic red, the depth depending upon the time of immersion, and which can be watched and arrested as desired. The print should then be washed and dried, and can be photographed with perfect success. A blue-print of a line drawing thus treated will give a negative having black lines upon clear glass, and this can then be backed with white paper and used for copy for a line engraving by the zinc or copper photo-engraving process.

MARKING NEGATIVES

A GOOD way to mark negatives is as follows: Use round paper disks, ¾ inch in diameter, and on these punch the numbers with a check perforating punch. The film is scratched off the negative for a space of about ⅜ x ⅝ inch, and the number, being previously soaked in water, is pressed on in position, sufficient moisture being in the paper to soften the gelatine on the negative and cause the number to adhere firmly to the plate when dry. A blue-print of each negative is then kept in a scrap-book divided off under different heads, such as electric cranes, locomotive cranes, motors, etc., and subdivided into different parts of the various machines, making it very easy for anyone to pick out the photograph required to show exactly what is wanted in each particular case much more readily than could be done by reading over a description which could not be detailed sufficiently to cover everything shown on the photograph. The negatives are kept in a case, ten to a division, the divisions being marked 10, 20, etc., up. The corner of the photograph, Fig. 52, shows the mode of numbering.

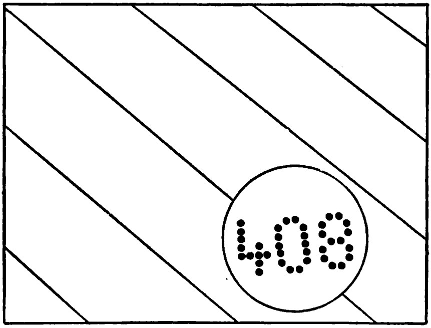


FIG. 52. — Marking Negatives.

A GLASS-COVERED DESK

THE following device will save many minutes each day for such engineers and draftsman as can apply it. This time-saver consists of a piece of plate glass large enough to cover one's desk or table-top, and a piece of drawing paper the same size to which various pages of formulas, tables and other oft-referred-to data are pasted. The paper, with the attached data, is spread out like a large desk-pad on the desk, and the glass laid on top of it. Some of the advantages of this device are that it affords an excellent surface on which to write; the data most needed are always in plain sight or easily referred to; the data are preserved, being none the worse for their constant use; new matter may be easily inserted.

RUBBER STAMPS IN THE DRAWING ROOM

A GREAT many times a draftsman could use a rubber stamp in his work if it were not for the fact that the ordinary stamp does not leave a line heavy enough to make a good, clear blueprint from, but leaves a faint mark which, if not looked for very closely, could easily be overlooked. A very satisfactory and also quick way to overcome this trouble is to use your stamp, and while the ink is still wet take an ordinary writing-pen and with plenty of ink (regular drawing ink) run over the stamped letters or figures quickly. You will find that the wet stamp ink will readily be followed by the other ink, and thus you will have a stamp mark in just as good condition as the rest of your drawing.

STIPPLING DRAWINGS

THIS is a process which has been used for many years for indicating stone-work on tracings. Pour a few drops of drawing ink into a saucer and by thoroughly smearing a round bristle brush about $\frac{3}{8}$ inch in diameter in this ink imitate the foundation, not by spattering but by *stippling* with the end of the brush. By using considerable ink on the brush and not much on the tracing an effect is produced which considerably resembles stone-work. It looks well and, what is more to the point, it prints well. To keep the stippling within proper limits, one of our acquaintances devised an adjustable shield. This consists of two pieces of heavy paper in the shape of a letter *L* with a slot cut in one leg of each piece through which the other leg is inserted. This makes the shield adjustable in all directions, as shown in Fig. 53. If made out of thin sheet brass or copper, it can be cleaned by washing and will last for years.

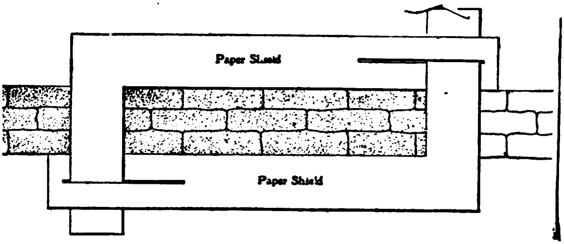


FIG. 53. — Adjustable Shield for Stippling Drawings.

DIMETRIC PROJECTIONS

EVERYBODY is familiar with isometric drawing as an easy and effective method of producing approximate perspective views, especially in cases when the object to be represented does not exist in reality, but is given, perhaps, by working drawings in ordinary rectangular projection. The facts that in isometric drawing all the straight lines are measured by the same scale and that the ordinary 30-degree triangle is used are undeniable advantages of the method. On the other hand it will be admitted that isometric views sometimes look awkward and unnatural.

Views that appear to the observer much closer approximations of true perspectives can be made by choosing different scales for the length, breadth, and hight of the object with corresponding angles. If a different scale is used for each of the three dimensions the projection is called a trimetric one, and evidently there are any number of such possible. When two of the three dimensions are measured by the same scale and the third by a different one the projection becomes dimetric; of such there are of course also any number possible, but there is one that is very easily handled and that yields very satisfactory pictures. In this particular dimetric projection the ratios of the scales are: 1: ½: 1, and the angles that the projections of the lengths and breadths of the object form with the vertical are such that their cotangents are ⅛ and ⅞ respectively, so that they may very easily be constructed. We had an instrument made some time ago consisting of a quadrangle embodying the above angles and a right angle. A sketch of the instrument is given in Fig. 54, together with a little perspective view showing its application.

To make the object appear full size in the perspective view the unit of scale employed for the same should be to the unit of the scale by which

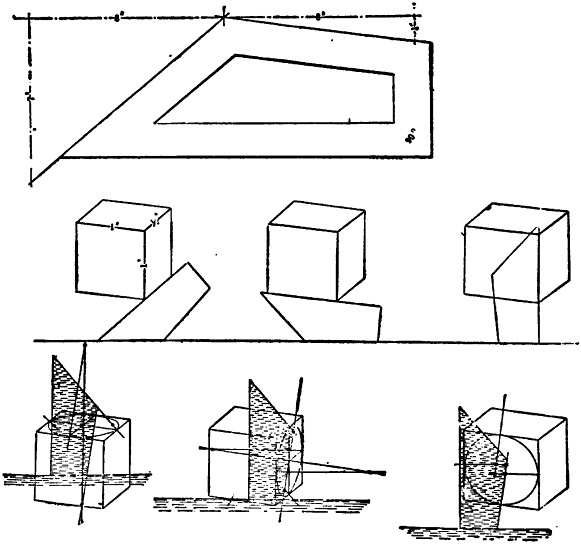


FIG. 54. — Dimetric Projections.

the actual object is measured as 1: 94; in the same manner as the scale employed in an isometric drawing is to the actual scale as is 1: 82. A pair of proportional dividers are used to advantage. As in isometric drawing, circles, of course, appear as ellipses. The centers of the circular arcs approximating these are easily located with the help of the instrument, as will appear from the sketches.

A DRAWING TABLE OF GAS PIPE

A STIFF and serviceable drawing table may be made out of gas pipe without much expense either for labor or material. Fig. 55 shows such a table, the legs and cross braces being of ½-inch gas pipe for a small table. The only castings for which special patterns are needed are the A-shaped pieces into which the legs are screwed and the segments which serve the double purpose of stiffening the wood top and also of affording room for a row of holes into which a pin may engage to fasten the top at any angle. The top turns on a ⅜-inch rod which runs the whole length of the table through a piece of pipe which acts as a separator, a nut on each end of the rod binding the whole together. The fastening device is a spring pin at the right-hand end of the table, details of which are shown. A register plate across the two bottom pipes serves as a foot rest.

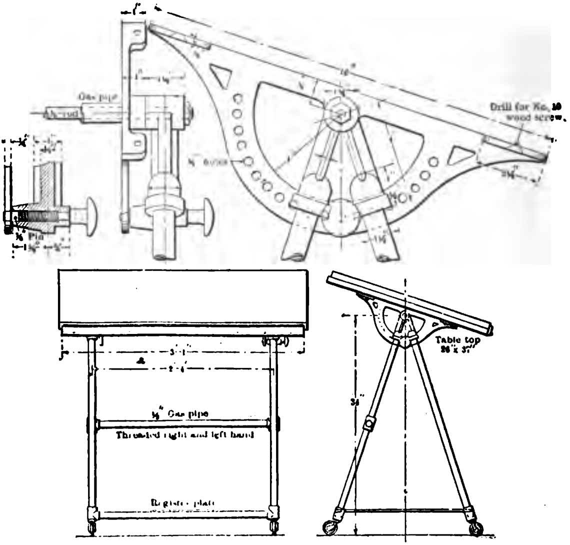


Fig. 55. — A Drawing Table made of Gas Pipe.

It will be noticed that no provision is made for adjustment in hight and none is intended. During an experience of nearly twenty years on a drawing table easily raised or lowered the user does not recall changing the hight half a dozen times, and in an examination of all the tables in an office where the hights of the men range from 5 feet 4 inches to 6 feet 2 inches, the tables were found to be within two inches of the same hight and might probably all be alike without inconvenience, the adjustment being effected by tilting the table top or by varying the hight of the stool.

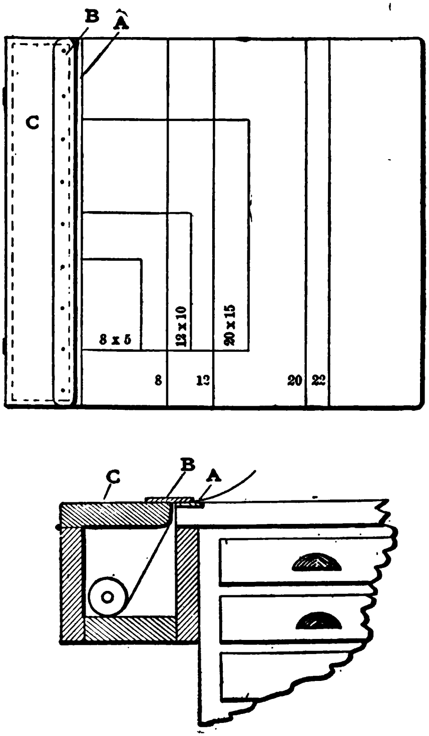
CUTTING UP DRAWING PAPER

THE following is a description of a paper cutting device which was added to a shallow chest of drawers.

Fig. 56 shows a plan of the top, and Fig. 57 a section of the box which holds the roll of paper.

A strip of hard-rolled brass *A* was let into the top of the drawers for a cutting plate, and another strip *B*, with a straight-edge, screwed to the hinged top of the box as a guide for the cutter.

The standard sizes of paper used at this shop are 30x22, 20x15, 12x10 and 8x5 inches. A roll of paper 30 inches wide is therefore most convenient. The top of the chest was ruled with lines, as shown. To cut the 8x5 size, the paper is unrolled a little and the lid closed to give



FIGS. 56 and 57. — Cutting up Drawing Paper.

friction and keep the paper taut. The end is put true with the line marked 8 and a strip cut off with a roller glass cutter. This strip is rolled up and partly inserted in the box and the edges adjusted to coincide with the rectangle marked 8x5 and cut off. This process is repeated five times on each strip of this size. In the same way the larger sizes are cut without any waste.

This method works very well and is quick and accurate and the edges true and smart. The cutter has a movable spindle, so that the wheel can be sharpened when necessary.

DRAWING BOARDS WITH A STEEL EDGE

Drawing boards are frequently made, as in Fig. 58, with a steel bar along the working edge, which is presumed to be ground straight within small limits of error. This presumption may be justified as regards the bar itself, but when attached to the board in the manner shown it is refinement thrown away. The bars should be heavy and broad enough to be sufficiently rigid when fastened by the end screws only, and these are all that should be used. The bar will then maintain its straightness and not follow the warping and twisting of the board due to atmospheric changes. There should be a slight clearance, as shown at *A*, so that the wood cannot bear against the straight-edge and curve it outward.

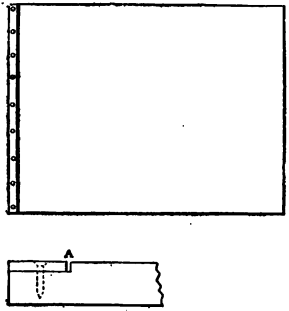


FIG. 58.

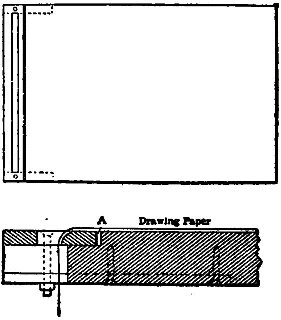


FIG. 59.

Steel Edges on Drawing Boards.

The slotted bar shown in Fig. 59 is designed to admit of long drawings being made on a short board. These bars are frequently fastened by screws at short intervals along the inner edge, but the shrinkage of the wood is sufficient to spring the outer edge of even a bar of this form, and it is much better when attached by only a single bolt at each end. Short steel bars are screwed to the under side of the board, projecting outward to support the straight-edge, as the slot in the latter must clear the end of the board.

A PRACTICAL SECTION LINER

Fig. 60 shows a practical section-liner which anyone with any mechanical ability can make. The little triangle in the center can be made of a piece of an old triangle or of a thin piece of wood. The length of notch 1 should be about 1.54; of 2, about 1.57, and of 3, about 1.60 inches. The length of A on the little triangle should be about 1.53; of *B*, about 1.52, and of *C*, about 1.51 inches, giving nine steps from one one-hundredth to nine one-hundredths inch, in steps of one one-hundredth inch. This makes quite a variety, but it can be doubled by making two small triangles instead of one. Those who have never used one of these section-liners will find it a little awkward at first, but with a little practice it can be operated very rapidly. The left hand should rest upon the T-square, with the index finger on the large triangle, and the next two fingers on the little triangle. To operate it, press down with the index finger and push the little triangle along to the right-hand end of the groove in the large triangle, with the other two fingers; then press down on the little triangle and push the

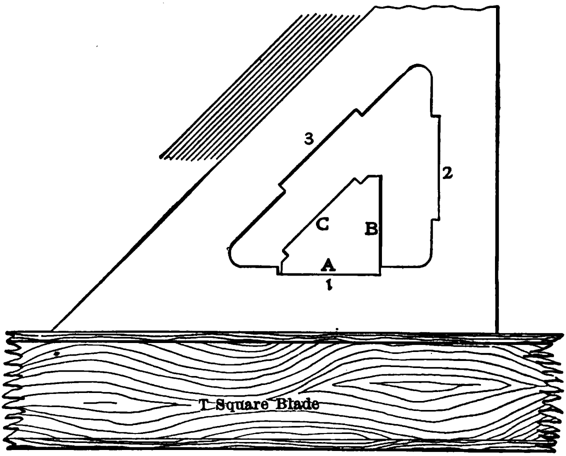


FIG. 60. — Section Liner.

large triangle to the right until it stops against the small triangle, repeating this as the work proceeds. With a little practice it can be operated faster than the ruling pen. One advantage this section-liner has is that it is always set and ready for use. In case of an old drawing requiring some changes, the section lining can be exactly duplicated, while with an adjustable section-liner considerable time would be wasted in adjusting it to agree with the section lining on the drawing.

AN INK BOTTLE HOLDER

THIS holder, Fig. 61, is made to hold one of Higgins' bottles, and is fastened to the under side of the drawing-table by one screw so that it may be swung in underneath out of the way, as shown in the sketch. We have these attached to all our tables and find them very handy. They have the advantage over all others in that they are always where they are wanted, and are never covered up by a multitude of drawings and their position eliminates all danger of spilling their contents, or of drippings from the filler getting on the drawings.

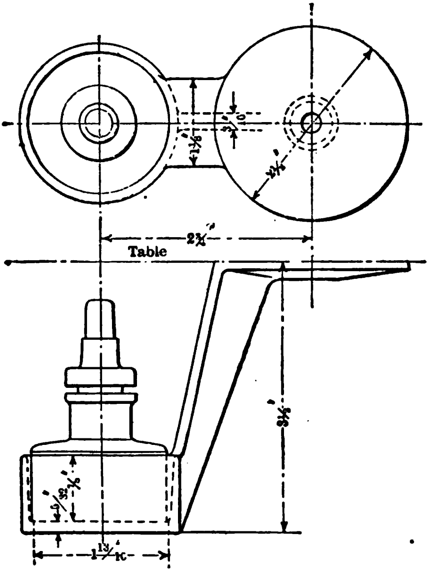


Fig. 61. — Ink Bottle Holder.

PATENT OFFICE DRAWINGS

Very little has been published about Patent Office drawing, and while this branch of the business is some distance removed from shop drawing, it is still drafting and the shopman may be called upon for this work or he may desire to take up that line. A set of drawings recently came into our office to be made over, having been rejected by the Patent Office; these drawings were the work of a competent man in some lines, but he lacked instruction in this work. It was this incident that suggested this article.

The ideal Patent Office draftsman is the man with the artistic temperament and having considerable mechanical training.

To begin with, there are certain rules laid down in the book, "Rules of Practice," issued by the Patent Office, which book may be had for the asking by addressing the Commissioner of Patents at Washington. These rules furnish us all the information about drawings that is issued by the Office. Anyone contemplating making Patent Office drawings is advised to get a copy of this pamphlet and study the same carefully.

Patent Office drawings are made on a standard Bristol board, "three sheet" being specified. The standard size is 10 x 15 inches, having a marginal line one inch from the edge, thus enclosing a space 8 x 13 inches. These sheets may be purchased of standard size and quality, marginal line and all, having the words "Witnesses," "Inventor," and "Attorney" in their respective positions at the bottom of the sheet.

A space of 1¼ inches is reserved at the top of the sheet, and will be filled in at the Patent Office. When beginning a drawing, rule off this reserved portion the first thing, and be careful about encroaching thereon, for neglect of this rule will bring a request for a new drawing.

Before beginning on the drawing, size up the device to be illustrated to determine what views will be required to show best the different parts in operation; what scale to make them; and how many sheets will be required. Fig. 1 is usually a view of the whole device, showing its general appearance as an entirety. A perspective view will often be most acceptable for Fig. 1, as it introduces the device to the attorney and to the examiner in a manner that appeals to them, for, as a rule, the people the Patent Office draftsman deals with are men not used to reading drawings.

The figures should follow each other in natural sequence, Fig. 1 being at the upper left of the sheet, and Figs. 2, 3, 4, etc., following from left to right and down the sheet. A little thought in this matter will make the work easier for the attorney, besides giving the case the appearance of having been worked over but once. The time-honored "meat-chopper," which is set forth as a model in the "Rules of Practice," is about as far out in this respect as it possibly could be. In this connection it might be well to call attention to the fact that a little care in placing the different figures makes a great difference in the looks of the work. Sometimes we have put in an extra figure that was not absolutely needed solely to present a well-balanced appearance.

Patent Office drawings differ from working drawings in several respects. Center lines are omitted, no dimensions are given, stresses are not figured, gear teeth are not accurately drawn, nor is any attention paid to scale in the usual sense of the term. It is often possible to simplify the work by departing from the unessential details of the model device. For instance, it is easier to make the legs of an improved table square instead of turned and ornamented; set-screws are easier to show than keys; a valve may be the merest approximation to an actual valve, and so on.

One thing, however, must not be overlooked: consistency must be preserved throughout the entire set of drawings. Each part must preserve its relative proportion, wherever it appears, whether in the perspective, section, or detail, so as to be easily recognized by whoever comes in contact with the work. This is a very important feature in this work, and must never be lost sight of.

Wherever patents are concerned there is liable to be more or less litigation, and the draftsman should always keep in sight the fact that his work may at any time be brought into court, and any discrepancies will surely be brought to light by the opposing counsel. An obscure or poorly made drawing will sometimes lose a patent suit.

When planning the different figures, aim to show each part in its position and to show each part but once. One figure may often be used to show a good many parts, thus saving drawing work and the attorney's time.

Patents afford the patentee a monopoly on a novel principle or a combination of principles; and the draftsman must keep this fact in mind, first, last and all the time. The details should be second to the principle, although some attention must be paid to them and the parts proportioned by eye to the work they perform, in order to avoid the grotesque drawings we sometimes see sent out from the Patent Office.

Most attorneys object to the use of dotted lines, and they are indeed very confusing. Sections may be used to show the different parts so that very few dotted lines are necessary. Dotted lines are sometimes used to show different positions taken by parts during some movement, and while such a use is perfectly legitimate, it seems to us that it is far better, except in unusual cases, to insert different figures to show the different positions of a movement.

When drawing gears, chains, etc., draw every tooth or link. These need not be correct from a mechanical point of view, but each one must be shown. The usual way of indicating screw threads applies in Patent Office drawing.

After the pencil work is finished, the drawing should be outlined in ink. In this part of the work do not be afraid to use plenty of ink; the more one uses the better the work will look. We shall have more to say of this later; but be sure to get the outline in bold, heavy lines.

The rules require the drawings to be made with India ink; the best to use is the almost universal "Higgins' Water Proof," for an accidental smear with a sweaty hand will ruin a drawing made with common India ink. The drawing must be executed throughout with the drawing instruments as very little free-hand work will be acceptable. This rule is a hardship at first, but one soon becomes used to the drawing pen for shadows, etc., and that method is really the easier.

Outline shading is to be used, darkening the lines on the right and bottom sides as the light is supposed to come from the upper left-hand corner of the sheet.

We are now ready for the shading. With a pencil sketch in the shadows as they may be conceived to fall. The surface shading should take the form of these shadows. Let the surface shading be open, the lines being from $\frac{1}{16}$ to $\frac{3}{32}$ inch apart, and in wood they may run in the direction of the grain. In order to make up for this wide spacing, make the lines heavy. This accomplishes several ends; the lines do not need to be so accurately spaced; time is saved, for there are fewer lines to be drawn; and, lastly, the reproductions will show up better. When shading convex or concave surfaces, use very heavy lines near the edges, working toward the center always, and let the shading come into the light rather faster than usual, something after the fashion that would be followed when shading an ellipse. This brings the light and shadow nearer together, and shows them both better.

In the back of the "Rules of Practice" is the "draftsman's chart" or plate of conventions. It is far easier and very acceptable to the office to use the plain hatching such as is indicated for wood or metal, for all sections, excepting perhaps liquids and electrical insulations.

The rules say to shade only the round surfaces, but most attorneys require a good deal of surface shading, and it certainly improves a drawing if well done. A few dead-black shadows improve the tone of the work; but use them sparingly, for it is against the rules. A reducing glass is a good thing to use when shading up a drawing, for one can tell about the strength of the lines and how the job will look in the *Gazette.*

Reference letters and figures are the last things. For designating the figures use the letter on the plate in the "rules." Reference figures are best rather small, say $\frac{1}{8}$ or $\frac{5}{32}$ inch high, made plain and open. Connect them with the parts they designate, with a wavy line rather than a straight line, to distinguish it from the lines of the drawings.

Long before this the draftsman has made a "miss lick." Just take a typewriter eraser and rub, not too heavily. If the surface of the paper is badly injured take a hard lead pencil and calender the place before inking again. Never use a scratcher until you are all through draw-

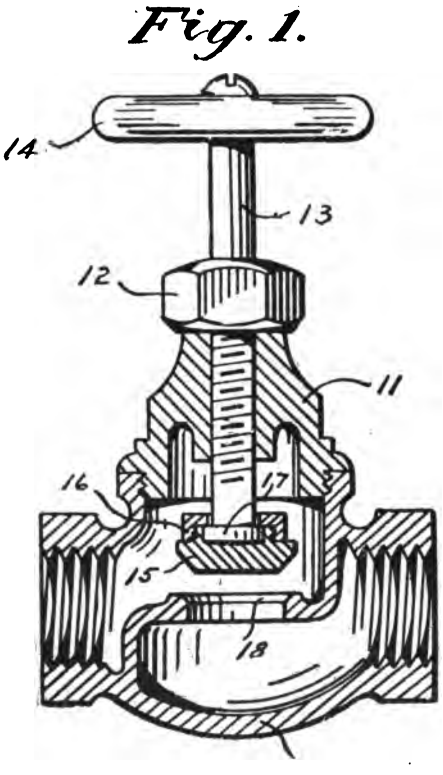


Fig. 62.—Patent Office Drawing.

ing, as a touch of a pen on a scratched place ruins the work.

Before sending the drawing away make either a blue-print or a vandyke. Either of these should be negatives. The blue-print takes about 20 minutes in a bright sunlight and the vandyke about 1½ hours. The vandyke has the advantage of being opaque and positive blue-line prints may be had from it at any time.

We attach a little figure, Fig. 62, that we hope will illustrate something of the above. "One example is better than ten precepts."

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